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TUMORS IN DOGS.

II. A Fibro-blastoma of the Alveolar Border of the Jaw Containing Giant Cells, (a Giant Cell Epulis).

By JONATHAN FORMAN and CARLOS I. REED.

(From the Laboratories of Pathology and Physiology of the Ohio State University)

According to Wolff, ('13) the dog is more frequently afflicted with sarcoma than any other lower animal. Frohner observes that sarcomas in the dog occur most often in the subcutaneous tissues. This author also mentions "Epulis sarkomatosa" as presenting itself frequently on the upper jaw of dogs and less frequently on the lower jaw. The specimen described here is not presented because of the rarity of the type, but because it apparently throws some light on the nature of the giant cells frequently seen in epulides.

Epulis is a topographical term signifying any growth upon the gums. Used in this broad sense, it may cover tumors of bone, connective tissue, epithelium, inflammatory conditions, and simple hypertrophies of the gums such as are occasionally encountered in pregnancy. The term, however, has become restricted to those tumors which are seated upon the gum or the upper edge of the alveolar border and which are of mesenchymal origin. In man three types have been described;

first, the fibrous epulis; second, the giant cell epulis; and third, the endothelial variety described by Whitman ('14) and Ivy ('15).   The term epulis, however, seems to us to be a poor one and we would prefer to see it replaced by the correct name of whatever type of tumor it happens to be.

The so-called giant cell sarcoma or epulis of the jaw has been the subject of controversy.   Some authorities claiming that it is a benign growth while others believe it to be malignant. Several causes have led to this confusion: first, the use of the term epulis, which does not define the type of growth; second,
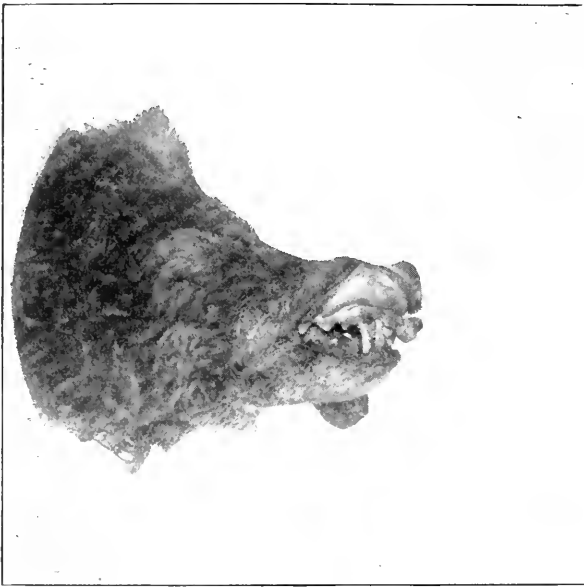
Fig. 1.   A Photograph of the Tumor.

too much importance has been attached to the presence of giant cells but without due attention to their nature; third, the giant cell fibro-sarcoma may have been confused with the endothelial variety described by Whitman ('14).

The tumor upon which this paper is based occurred upon the upper jaw of a dog which came into the Laboratory of Physiology during the school year 1915-16.   The dog was an adult mongrel shepherd whose age was unknown.   The accompanying figure gives an adequate idea of the size and location

of this growth.   It measures 3 x 2 x 15 cm. and is attached by
a pedicle 1 cm. in diameter to the gum margin between the
incisor teeth.   It is firm, and covered by a mucous membrane
of normal color, except at the extreme tip, where the covering
has taken on a warty appearance.   The tumor is not ulcerated
at any point.

Microscopal examination reveals a fan-shaped section cov-
ered except at the point of attachment of the tumor by a normal
appearing epithelium.   The outer half of the tumor is composed
of normal appearing fibro-blasts.   Just beneath this in the
connective tissue is a zone of giant cells.
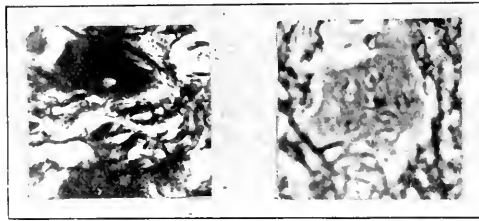
Fig. 2.   Giant cells containing reticular fibrils.

The distinctly neoplastic cells are more closely packed in
the pedicle of the tumor.   While there has occurred an elabora-
tion of inter-cellular substances in this area, they are not so
rich in amount as in the older portion of the tumor.   There is,
however, a sufficient degree of differentiation on the part of the
connective tissue cells composing the tumor in this growing
portion to place it among the benign fibroblastomas.

Giant cells are generally thought to be produced by fusion
of cells or else by division of the nucleus without a corresponding
division of the cell body.   Mallory ('11) has called attention
to the presence of both types in sarcomas.   Those, which are the
product of an incomplete multiple mitosis of the tumor cells, he
calls "The true tumor giant cell."   These are much less
frequently found than the other type and are indicative of
the rapid rate of growth of the tumor.   Since a careful search
fails to reveal any evidence of mitosis in any of the nuclei
of the giant cells seen in this specimen, it is probable that
these belong to the fusion type of giant cell.

It is usually stated that the type of giant cells due to fusion
is most frequently found in tumors associated with bone,

although at times, as in this specimen, all the neoplastic cells are fibroblasts and there is no evidence of either bone or cartilage formation.   This tumor, however, arose from or near the periosteum.   From this close association with bone, it has been suggested that these giant cells were identical with osterclasts. This type, Mallory says, (*loc. cit.*) "Is due to endothelial leukocytes invading tumors, especially those involving bone, and fusing to form foreign body giant cells.   They are not tumor cells (although the tumors containing them are the ones which receive the name giant cell sarcomas) and usually signify only erosion and disintegration of bone."   In addition to this source, the origin of osteoclasts has been assigned to reticular cells and to osteoblasts.

It would be of interest then to determine if possible whether the giant cells in this fibroblastoma were really brought about by a fusion of cells as they appear to have been and also whether the cells which entered into their formation were tumor cells or were cells that had infiltrated the tumor from some outside source.

Sections from this specimen were impregnated with silver after the method of Maresch-Bielskowsky.   By using this method, Dr. James H. Warren has studied the nature of the giant cell seen in early tubercles ('17).   This technique as employed by Ferguson ('12) would appear to be well established as a specific stain for reticular fibrils.   These fibrils are abundant in this tumor.   This is not surprising when it is considered that this is a tumor of rather slow growth arising in the connective tissue of the jaw.   Some of these fibrils appear to leave the cytoplasm, and are seen free, while others bear only a faint rim of cytoplasm.   The giant cells are especially interesting when stained with this silver impregnation.   In many of the smaller giant cells, which contain only a few irregularly placed nuclei, the arrangement of fibrils together with the outline of the protoplasm suggests that the giant cells have been formed by the fusion of the reticular cells. Even in some of the larger giant cells, reticular fibrils can be seen in the cell body.   These facts together with the complete absence of any evidence of mitosis would make it appear that these cells have been formed by a fusion of the reticular cells rather than by the fusion of invading cells or by multiple mitosis of the tumor cells.

This specimen represents a neoplasm of slow growth in close association with bone.   Since there are normally reticular

cells at the point of origin of this tumor and since there is a close association of reticular fibrils with the giant cells as well as with the tumor cells, it seems indicated that the giant cells in this tumor are produced by the fusion of tumor cells and for this reason present a tendency to differentiate as do the cells from which the tumor arose.

That this is not the only mode of origin of fusion giant cells seen in new growths is apparent from the description of the origin of such cells by Whitman ('14). An examination of the specimens of giant cell sarcoma in the Museum of Pathology at the Ohio State University has shown that some of the giant cells originate from endothelium. This agrees with Mallory. It is the behavior of the more undifferentiated cells that determines the clinical course of the growth of the tumor. Giant cells such as are seen in this specimen become, therefore, of secondary interest for they do not determine the classification of the tumor as a fibroblastoma. They, however, indicate that the tumor is relatively benign. This is in agreement with Ivy's conception ('15) that the presence of these giant cells indicates that the tumor is probably not malignant.

SUMMARY.

This tumor arising in the alveolar process of the upper jaw of a dog is a rather slowly growing fibroblastoma, which contains giant cells.

By the application of the Maresch-Bielskowsky technique of impregnating with silver it is established that the tumor cells possess black argentiferous fibrils and that the giant cells present in this tumor are produced by the fusion of cells which also have these same fibrils in close association with them.

BIBLIOGRAPHY.

1. **Ferguson,** 1912. The Application of the Silver Impregnation Method of Bielskowsky to Reticular and Other Connective Tissues. Am. Jour. Anat. Vol. XII, p. 277.
2. **Fohner.** (Cited by Wolff).
3. **Ivy,** 1915. Mesothelial Tumors of the Jaws. Jour. Am. Med. Assn. LXIV, 40.
4. **Mallory,** 1911. Giant Cell Sarcoma. Jour. Med. Res. Vol. XIX, p. 463.
5. **Means & Forman,** 1915. Precancerous Conditions of Face and Mouth. Dental Summary, XXXV, p. 945.
6. **Means & Forman,** 1916. Epulis. Dental Summary. XXXVI, p. 494.
7. **Means & Forman,** 1917. A Clinico-Pathologic Study of Early Malignant Conditions of Face and Mouth. Jour. Am. Med. Assn. Jan. 20, 1917. p. 180.
8. **Warren, James H.,** 1917. The Giant Cell in Tuberculosis. Jour. Med. Res. Vol. XXXVI. No. 2. May, 1917.
9. **Whitman,** 1914. Giant Cell Endothelioma of the Gums. Jour. Med. Res. Vol. XXIV, p. 465.
10. **Wolff,** 1913. Lehre von der Krebs Krankheit. Jena. 1913.

THE AXIAL ROTATION OF AQUATIC MICROORGANISMS AND ITS SIGNIFICANCE.

L. B. WALTON.

Some studies concerning the axial rotation of aquatic microorganisms occupying my attention during the last two years, have yielded results which it is believed are of decided importance in connection with the principles underlying evolution.

In general it may be stated that the positively phototactic free swimming forms of the northern hemisphere rotate clockwise, assuming the observer in front of the advancing organism, and the negatively phototactic forms counter-clockwise, while in the southern hemisphere there are reverse conditions. The apparent exceptions thus far noted have been found closely allied to northern forms and may have been introduced subsequent to the origin of the southern forms.

The evidence although far from complete is gradually accumulating that the characteristic is one which has been gradually impressed upon the organisms through the rotation of the earth and the apparent path of the sun from east to west. Any attempt to account for it on the basis of natural selection can scarcely gain credence. While the possible effects of the angular velocity of the earth or of certain electrical conditions may be considered, it does not seem that the result could in this way be explained. Experimental attempts to reverse or to diminish the rapidity of the rotation of the organisms have thus far failed.

The problem is an interesting one from the geophysical as well as the biological point of view, and many interesting principles come under consideration. Among these may be mentioned the Pendulation Theory, Bipolar Distribution, The Twining of Plants, The Tropism Theory, etc. Similarly the direction of the spirals in Spirochaeta, Spirulina, Arthrospira, Spirogyra, etc., are of interest.

Modern genetics throws light on the distribution but not on the origin of the character producing genes or factors. These units have in general long been in existence. It is to some such principle as the one suggested that we must look for evidence sufficiently definite to overcome the prejudice which has arisen against the old acquired character ideas as to the fundamental origin of characters.

There is need of studying, in this connection, the behavior of microorganisms near the equator as well as in the southern hemisphere, particularly in an experimental way, before definite conclusions may be drawn.

Kenyon College, Gambier, O., Oct. 15, 1917.

CONCRETIONARY FORMS IN THE GREENFIELD LIMESTONE.*

Charles W. Napper, Greenfield, Ohio.

The locality of this study is at Greenfield, in southwestern Ohio. The workings are the Rucker Quarries. The rock is a Silurian dolomite, the quarry face above and below water-level measuring sixty (60) feet. Characteristic features divide the exposure into two parts, called the Gray Stone for the lower twenty(20) feet and the Buff Stone for the upper forty (40) feet.

In this paper the term "concretionary force" is employed in the sense and with the idea of the aggregation of rock material into various forms which are distinctly different from the surrounding stratification.

THE GRAY STONE—THE ISOLITH.

Herein the concretionary force is manifested in one single form. This stone is very evenly bedded, the ledges maintaining horizontal regularity unless there is interference from large, irregular, unstratified masses over which they bend.

The quarrymen call these masses "horsebacks" or "blisters" and this has caused the writer to search for possibly a better name. While producing a disturbance somewhat similar, the terms *laccolith* and *batholith* can not be used for they refer to conditions produced by the intrusion of one kind of rock, igneous, into another, hence two kinds of rock material are involved. In our instance, the masses causing disturbance and the strata disturbed are of one and the same rock material. Therefore I suggest and have used the term "isolith" for them.

*This paper, accompanied by lantern slide views and an exhibit of forms described, read before the Geological Section of the Ohio Academy of Science, meeting in Columbus, at the Ohio State University, April 7, 1917.

These isoliths have 8 x 10 x 12 feet as average dimensions and appear as large ovals.   They are a hindrance to quarrying, being difficult to break up and causing unevenness in adjacent ledges.   Operations downward usually cease when they are reached.

The first isoliths studied were of solid texture and not fossiliferous, and I was then disposed to regard them as a form separate and distinct from the brecciation well known as occurring

Fig. 1.   An Isolith.   Curving Strata Clearly Shown.

in the Monroe formation, of which the Greenfield Limestone is the basal member.   But later finding isoliths of brecciated structure and fossilferous, and unable to observe the resumption of stratification beneath, I am now rather of the opinion that both forms, to some degree, are manifestations of the same force of aggregation.   Why then I continue to mention isoliths among concretionary forms, will appear in the correlation I shall present further on in this paper.

Isoliths afford us two interesting features—ledges can often be traced through them and come out on the other side—they sometime contain a fauna not characteristic of the immediately surrounding ledges.

Glacial Drift Material—10 to 15 feet.

Concretionary Whorls (rare)

Waffles

Concretionary Pebbles

Masses

Buff Stone
40 ft.

"Cup and Cone"

Concretions

Total
Section
60 ft.

Gray Stone
20 ft.

Isoliths
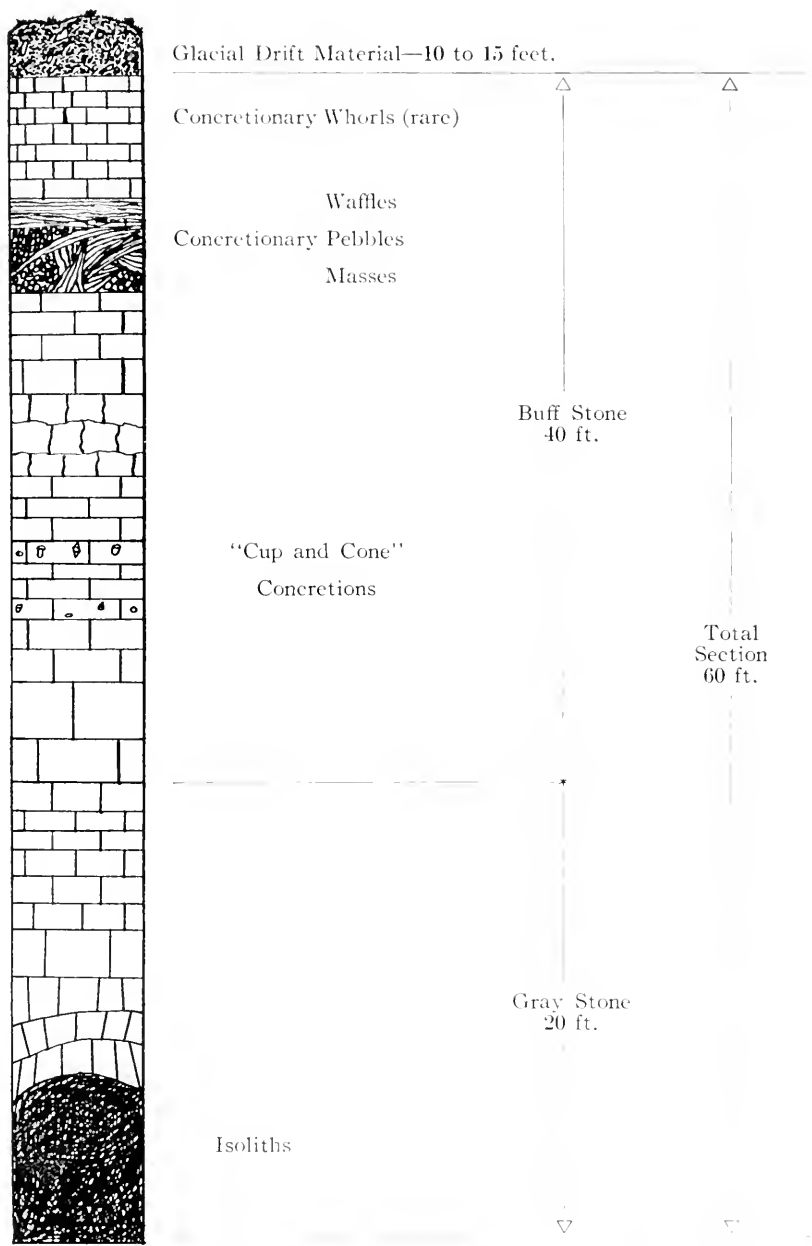
Section at Rucker Quarries, showing position of Concretionary Forms.

THE BUFF STONE.

The largest number of concretionary forms are found in the Buff Stone—the lower fifteen (15) feet containing "cup and cone" concretions, and the upper twenty-five (25) feet having the concretionary "masses, pebbles, waffles, and whorls."

The "Cup and Cone" Concretions.—In the lower ledges of the Buff Stone, especially in two or three strata, these forms are found plentifully and continue so horizontally throughout their zone.

Fig. 2.   "Cup and Cone" Concretion in Position in Buff Stone Ledge.

As a standard form, the "cup and cone concretion" consists of a cap, a cone, a cavity and its filling. From this we find every possible variation by the irregular combination of these parts. Additionally we have the "double" variety, two cones with one common cavity. The accompanying drawings show a perfect form and the variations. In length they are one to ten inches and one to five inches in diameter at the largest part. Usually stems or cones are round in cross section, although frequently found oval.

The filling of the cavity presents an interesting study and may be—the cavity partly or tightly filled with small lenticular pieces of the same rock material appearing as crushed and pressed into it—partly or completely filled with "rock tar,"

the result of carbonaceous material draining in and solidifying—
lined or filled with quartz crystals, through which sphalerite
may be disseminated—containing well formed crystals of
sphalerite—or filled with a brownish, carbonaceous clay. These
last two are very rare forms. These cavities are objectionable
in building stone.

We now pass to the concretionary forms found in the upper
ledges of the Buff Stone.

Concretionary "Masses".—Usually these forms appear as a
distinct, continuous ledge five to thirty inches thick and two
to five in number. They rarely disturb adjacent layers, there-
fore "contorted ledges" is a term more suggestive of their
structure.
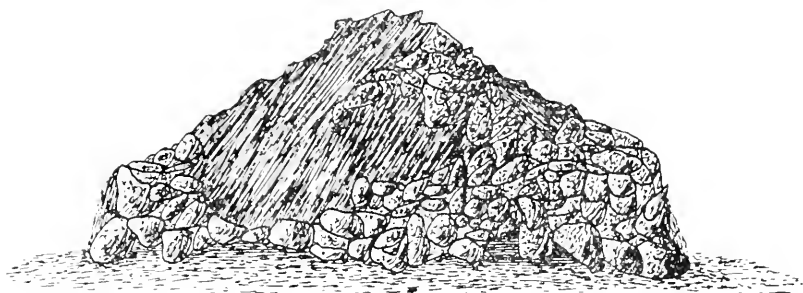
Fig. 3. "Concretionary Pebbles."
Sketched from a piece 5 x 12 x 3 inches.

Concretionary "Pebbles."—Frequently within the "contorted
ledges" are found bunches or clusters resembling a conglomerate
of rather large pebbles. These pebbles are usually round, about
one inch in diameter and other sizes and shapes occur. When
broken for cross section, they reveal a ring around ring structure
somewhat similar to that of an onion.

Concretionary "Whorls."—A rare form in the Rucker
Quarries, but frequently found in other exposures of the thin-
bedded upper Greenfield Limestone. They appear as fine lines
drawn around a center then joining into one another. May
prove to be a fossiliferous form.

How could rock material aggregate into these various forms,
especially in strata so evenly bedded? How could this occur
while all forms and strata are of the same rock material? How

were the ledges arched and the space filled in? Or are the forms contemporaneous with their surrounding strata? Why out of the six forms only two are frequently found in other exposures of the same limestone in the same locality?

The "cup and cone" concretions with their cavities often filled with rock pieces crushed in, suggest pressure as a cause. But then why are they not found in the lower Gray Stone where pressure would be greatest? Why do they occur most frequently in a few ledges near the middle of the exposure?   Always being vertical, seldom inclined and never horizontal, has this definite position any importance?   The lithological differences between the Gray and Buff stones, have they any bearing on the problems involved?   These important questions I desire to submit for further, careful consideration.

<div align="center">CORRELATION.</div>

I have found specimens which are suggestive that there may be a relationship between these and other concretionary forms.   If this can be sustained, then we have made quite an advance towards the explanation of the common force which has operated, what it is and how it has operated.

At the center of an unbrecciated, unfossiliferous isolith which had been bisected, I found a large mass of sphalerite, well crystallized and weighing thirty (30) pounds.   Its position was suggestive that it had been the nucleus of the isolith's aggregation, a striking similarity to where concretions are formed with fish bones, leaves, etc., as nuclei.

Embedded in a fossiliferous, unbrecciated isolith I have found concretionary "pebbles" with characteristic ring around ring structure in cross section.   This seemingly joins my lowest and next to highest forms as the result of a common force.

The stem of the "cup and cone" concretion sometimes has a structure somewhat similar to the "cone in cone" form. As pressure is now regarded the probable cause of the latter, any relationship that can be established with the former is evidence of some corroborative character for the pressure theory.   The crushed-in particles in the cavity are ever strongly suggestive of pressure.

In the disturbed ledges near the contact with the isolith, I have found smoothed, grooved portions.   This is evidence

of pressure and movement, either the isolith upward or the ledge downward.   Can such occurrence be of use and value to the pressure theory?

The arches of the concretionary "waffles" sometimes become so high, large and shaped, as to be suggestive of a transition into the "pebble" form.

In the gorge of the Cuyahoga River near Akron, just below the electric power-house dam, in the bluish sandstone, I found two ordinary and familiar round concretions about eight (8) inches each in diameter and not requiring more than twenty (20) inches of space in length over all.   Midway between these, I found a concretion very similar to the "cup and cone" type. It has a cap, a stem or cone and an oval end suggestive of a cavity.   If this similarity has merit, then we have joined an additional form to the series.

These observations are presented in the hope that they will be found to be clews of some value and assistance in arriving at a full and complete understanding of the concretionary force and the forms resulting from its operation.

We now see that the Greenfield Limestone has features of intense interest which its usual regularity would seem to preclude.

REPORT

OF THE

TWENTY-SEVENTH ANNUAL MEETING

OF

THE OHIO ACADEMY OF SCIENCE

The Twenty-seventh Annual Meeting of the Ohio Academy of Science was held at Ohio State University, Columbus, Ohio, April 6 and 7, 1917. In the absence of the president, Professor F. O. Grover, of Oberlin College, Professor Stephen R. Williams, of Miami University, vice-president for Zoology, presided over the meeting. Fifty-one members registered in attendance.

GENERAL PROGRAM

FRIDAY, APRIL 6

9:00 A. M.—Business Meeting.

10:00 A. M.—Reading of Papers in General Session.

11:45 A. M.—Illustrated Lecture by Professor Robert F. Griggs, of Ohio State University: "Recent Explorations of Mt. Katmai, Alaska." In Place of Presidential Address on "Some Phases of Present Day Biological Unrest," by Professor F. O. Grover, of Oberlin College, whose attendance was prevented by illness.

12:15 P. M.—Lunch, Ohio Union.

1:30 P. M.—Reading of Papers in General Session.

3:00 P. M.—Reading of Papers, in Sectional Meetings.

5:45 P. M.—Dinner, Ohio Union.

7:30 P. M.—Public Lecture by Professor James R. Withrow, of Ohio State University: "The Relation of War to Chemistry in America."

SATURDAY, APRIL 7

9:00 A. M.—Adjourned Business Meeting.

10:00 A. M.—Reading of Papers in Sectional Meetings.

MINUTES OF BUSINESS MEETINGS

The first business session was called to order by Vice-President Williams at 9:00 A. M., on Friday, April 6. An adjourned session was held at 9:00 on the following morning.

The appointment of the following committees for the meeting was announced by the chair:

Committee on Membership—M. E. Stickney, A. W. Smith, F. L. Landacre.

Committee on Resolutions—E. L. Moseley, L. B. Walton, C. G. Shatzer.

Committee on Necrology—G. D. Hubbard, Herbert Osborn, A. D. Cole.

The following Auditing Committee was elected by the Academy: L. B. Walton, C. G. Shatzer.

The following Nominating Committee was elected by the ballot of the Academy just before the close of the first business session: L. B. Walton, G. D. Hubbard, A. D. Cole.

Report of the Secretary

The following report by the Secretary, read by the Acting Secretary, was received and ordered filed:

CAMBRIDGE, MASS., March 31, 1917.

To the Ohio Academy of Science:

The work of the Secretary for the past year has consisted mainly of routine work, largely in co-operation with the Executive and Program Committees.

A brief report of the Twenty-sixth Annual Meeting, 1916, was published in SCIENCE, July 28; the full report appeared in the OHIO JOURNAL OF SCIENCE for January. Notices of the present meeting have been sent to the leading dailies in Columbus, Cleveland, Cincinnati, and Toledo.

The officers of the Academy were notified of their election; and the relevant portions of the report of the Committee on Resolutions were transmitted to all persons and organizations receiving recognition in that report.

The Program Committee is to be congratulated on securing the services of Prof. Withrow for the Friday evening address. Prof. Withrow is giving this very timely address at serious personal inconvenience. His loyalty to the Academy and the spirit of national patriotism by which he is actuated should receive the fullest recognition of the Academy.

The gratitude of the Academy is also due to Prof. Griggs for his kindness and telegraphic promptness in filling in the gap in the program caused by the illness and absence of the President.

Two minor matters concerning the make-up of the program may well be mentioned here. Some members may be disappointed to find their papers scheduled for sectional meetings rather than general sessions; this has been necessitated by the presentation of an unusual number of titles of a general character. There have been presented, also, an unusually large number of titles unaccompanied by specifications as to time needed. This causes no inconsiderable complication in the arrangement of the program. A uniform allowance of ten minutes has been made in such cases; for the future the secretary would recommend the reduction of this allowance to five minutes.

During the past year the Secretary has prepared a card catalog of the membership of the Academy, past and present, with record of dates of admission and withdrawal. Some inaccuracies (due largely to variation in spelling and to change of name on the part of the ladies) are still to be corrected; but the following summary is approximately correct, and may be of interest to the members:

Ex-Members..455
Present Members.......................................265
                                                     ———
  Total...720

The preparation of this catalog has made possible the record in the published membership list of the dates of admission to the Academy. The Secretary will be grateful for the correction of any errors which may have slipped into this record.

Preliminary steps have been taken this year looking toward the establishment of sections for Psychology and Chemistry; and it is hoped that another year may see these sections organized. The secretary has also very recently received the suggestion of the desirability of a section for the medical (or near-medical) sciences—Anatomy, Physiology, and Pathology. The program of this meeting shows the justification for this suggestion.

Some complications have arisen because of the Secretary's temporary absence from the state, but it is confidently expected that the very efficient work of Prof. Krecker as chairman of the Local Committee and of Prof. Westgate as Acting Secretary for the meeting will prevent any loss to the Academy.

Respectfully submitted,

EDWARD L. RICE, *Secretary*.

Report of the Treasurer for the Year 1916-17

The report of the Treasurer was received as follows, and referred to the Auditing Committee, whose report is appended.

For the year since our last annual meeting, the receipts, including balance from last year, have amounted to $590.73, and the expenditures to $451.63, leaving a cash balance of $139.10.

<div align="center">RECEIPTS</div>

Balance from last year....................................	$298.13
For sale of publications.................................	22.60
Membership dues.......................................	270.00

<div align="right">$590.73</div>

<div align="center">EXPENSES</div>

Miscellaneous expenses..................................	$ 48.88
180 subscriptions to the Ohio Journal of Science..............	180.00
Publishing Annual Report of the 25th meeting..............	222.75
Balance, April 6, 1917..................................	139.10

<div align="right">$590.73</div>

<div align="center">Respectfully submitted,</div>

<div align="right">JAS. S. HINE, *Treasurer.*</div>

<div align="right">April 7, 1917.</div>

The Auditing Committee has verified the receipts and expenditures of the Treasurer of the Academy, Professor J. S. Hine, and finds that they are correct.

<div align="right">L. B. WALTON
C. G. SHATZER.</div>

Report of the Executive Committee

The report of the Executive Committee was received as follows and ordered filed.

<div align="right">CAMBRIDGE, MASS., April 2, 1917.</div>

To the Ohio Academy of Science:

The Executive Committee has held but one meeting during the year, on January 27. The officers of the Academy were invited to meet with the Committee. Profs. Hine, Walton and Rice, of the Committee were present, together with Profs. Foerste, Osborn, Schaffner and Westgate by invitation.

It was decided to hold the annual meeting on April 6 and 7, in Columbus.

The Program Committee was instructed to arrange an independent session of the Academy for Saturday morning, and to arrange for a joint meeting with the Ohio College Association for Friday evening *only* in case of agreement upon a distinctively scientific address. (When Prof. Withrow accepted the invitation to speak at the Friday evening meeting, an invitation was extended to the Ohio College Association to join with the Academy; but other arrangements had already been made.)

Dr. Mendenhall was appointed to fill the vacancy in the Board of Trustees of the Research Fund caused by the death of Prof. Lazenby; and Prof. Fenneman was requested to serve as chairman of the Board.

Prof. Westgate was appointed as Acting Secretary to serve during the absence of the Secretary.

The following communication from the Ohio State University Scientific Society was presented by the Secretary:

Columbus, May 29, 1916.

Professor E. L. Rice, Secretary Ohio Academy of Science,
Ohio Wesleyan University, Delaware, Ohio:

DEAR PROFESSOR RICE:—At the last meeting of the Ohio State University Scientific Society it was unanimously voted that the Ohio Academy of Science be requested to name "a representative of each section of science represented in the Academy (Zoology, Botany, Geology, Physics), to serve on the Editorial Board of the Ohio Journal of Science," such representatives (four in all) not to be members of the Ohio State University Scientific Society.

Will you be so kind as to notify such officers of the Academy as should receive this announcement.

Sincerely yours,

R. J. SEYMOUR, *Secretary.*

Owing to the near approach of the annual meeting, no formal action was taken by the Committee, but the appointment of representatives was left to the Academy as a whole.

In November, 1916, the Executive Committee decided by correspondence to join with other organizations in extending an invitation to the Central Association of Science and Mathematics Teachers to meet in Columbus next Thanksgiving. The following letter from the President of that Association should be presented to the Academy:

COLUMBUS, March 21, 1917.

E. L. Rice, Secretary, The Ohio Academy of Science, Delaware, Ohio:

MY DEAR MR. RICE:—You will recall that your organization joined with a number of other organizations of the state in extending to the Central Association of Science and Mathematics Teachers an invitation to hold the next meeting in Columbus. The Central Association will meet in Columbus, November 30 and December 1, 1917. I take this means of suggesting to you that the Association will deeply appreciate any co-operation you may find it possible to give.

There will be a general meeting on Friday morning to which all are invited and at which a Science address will be made in addition to a general educational address. On Friday afternoon the sectional meetings will be held. On Friday evening there will be a banquet followed by detailed reports of plans for science and mathematics work in "The High School of To-morrow." On Saturday morning the general business meeting is held, followed by excursions to various places of interest in or near Columbus.

The Association invites you to be present and to take part in any and all of these meetings. The inspiration of this large body of teachers should be of great benefit to every similar organization in the state. Let us make this the biggest Science and Mathematics meeting ever held in Ohio.

Plan now to be present at the November meeting.

Yours very truly,

MARIE GUGLE, *President.*

This invitation has been acknowledged by the Secretary.

A single application for membership has been approved by the Executive Committee, and will be presented later for the ratification of the Academy.

Respectfully submitted,

EDWARD L. RICE,
Sec'y for Committee.

Report of the Publication Committee

The report of the Publication Committee was received as follows and ordered filed.

The committee has published the Report of the Twenty-fifth Annual Meeting, consisting of 202 pages and also the Report of the Twenty-sixth Annual Meeting, consisting of 26 pages. The first report was published at a cost of $222.75, and the twenty-sixth, which was a partial reprint from the Ohio Journal of Science, at a cost of $42.00.

The method of publication of the Proceedings of the Annual Meetings was not fully determined at the last meeting. The Executive Committee having been given power to act on its own initiative. After correspondence with members of the Executive Committee it was thought best to publish the Annual Report as heretofore, the first twelve pages consisting of list of officers and members, being set up separately, and the Secretary's Report reprinted from the Journal of Science. It was not thought necessary to reprint the President's address, since this will now be published regularly in the Ohio Journal of Science.

The committee recommends that the Proceedings of the Academy be handled in the regular way as heretofore, and that the Annual Report mainly a reprint from the Ohio Journal of Science, consisting of lists of officers and members, and the Secretary's Report be continued. The committee strongly urges that the publication of special papers be continued also and that if possible at least one be published each year.

Respectfully submitted,

JOHN H. SCHAFFNER, *Chairman*,
L. B. WALTON.

Report of the Emerson McMillin Research Fund

The following report of the Trustees of the Research Fund was received and referred to the Auditing Committee, whose report is appended.

April 5, 1917.

RECEIPTS

Balance April 21, 1916	$308.41
Check from Emerson McMillin	250.00
	$558.41

EXPENDITURES

Forest B. N. Brown	$ 46.25
B. H. Wells	40.00
W. L. Du Bois	21.50
Stephen R. Williams	41.69
Wm. M. Barrows	19.60
Balance in Bank	389.37
	$558.41

N. M. FENNEMAN.

April 7, 1917.

No report on the McMillin fund by the Auditing Committee is possible, inasmuch as vouchers, paid checks, and bank book are not submitted.

L. B. WALTON,
C. G. SHATZER.

Report of the Library Committee

For the Library Committee, Mr. Reeder, of the Ohio State University Library, presented the following report, which was received and ordered filed.

To the Ohio Academy of Science:

The Ohio State University Library begs to report that it has cared for all the accessions to the Library of the Academy, which have been received during the year 1916-17. The number of publications is not large, aggregating about one hundred (100) items.

During the year the annual reports of the twenty-fifth and twenty-sixth meetings of the Academy, for 1915 and 1916, were published. Copies were mailed to all members whose names appeared in each report and to all exchanges.

The sale of publications for the year has amounted to $22.60. This sum has been turned over to the Treasurer.

The librarian desires to raise three questions on which he would like a vote of the Academy:

1. Is there any policy regarding the number of copies of a Special Paper which may be presented to the author? Request was made during the year, by an author, for copies of his publications. Under existing arrangements the only disposition is by sale, after distribution has been made to the membership and to the exchanges.

2. Is there any policy regarding the reprinting of Special Papers, which are nearing exhaustion? Special Paper No. 15, "Trees of Ohio and Surrounding Territory," by J. H. Schaffner, is almost gone, there being only seven copies in stock. A request for eighteen copies for use in a university had to be turned down.

3. Is the Academy ready to take a further step in the management of its library and turn its collection over to the Ohio State University for incorporation with the other sets and books on scientific subjects?

In the original agreement between the Academy and the University, adopted November, 1914, it was stated in article 3, that "for the time being" the library of the Academy should be kept as a separate collection. This has been done. In article 4, it was stated that "ultimately it is mutually agreed that the library of the Academy shall be classified with, and distributed in the University Library."

The question is: Is the Academy ready to take this step at this time? The University Library is ready.

As bearing on this proposition, the following statements are submitted:

(*a*)   The Ohio Journal of Science is receiving a subsidy from the University.   In return for this annual grant, the University Library receives 250 copies of each issue for exchange purposes.   At the present time, some 230 societies and periodicals are on the exchange list. Furthermore, the Biological Club has turned over to the University Library all the exchanges received by the Ohio Naturalist from 1900 to 1915.   This material has been bound, catalogued and classified by the Library.

(*b*)   Some confusion exists between the two sets of exchanges, those received by the Academy and those received by the Library through the Ohio Journal of Science.   If the proposed step is taken, the two sets of exchanges can be unified and duplication eliminated, both in sending and in receiving.

(*c*)   If the proposed step is taken, the duplicates found in the Academy's collection can be used to secure other sets not now in the possession of either the University or the Academy, or they can be sent to other Ohio libraries as the Academy may decide.

(*d*)   The University Library has been purchasing from its book budget, many new sets and filling in the gap in existing sets.   If the Academy's collection is turned over, a number of its sets can be completed through purchase, something the Academy cannot afford to do. Furthermore, there will be no chance for duplication or waste in money, when the complete sets are purchased by the University of which the Academy has a partial or incomplete file.

(*e*)   The University Library is unifying other exchanges received and distributed by the University, such as the Ohio History Teacher's Bulletin, the Contributions from the Department of Zoology and Entomology, the Doctoral Dissertations, and the proposed series of studies to be issued by the Graduate School.   If the Academy agrees to the proposition put forward, all readjustments can be made while the work is being done on these other series, and the entire question of exchanges can be settled.

(*f*)   The result of favorable action on the part of the Academy will be advantageous to both parties, because the members of the Academy will get improved library facilities through a better handling of its own sets and exchanges and the University Library will be in a better position to unify its collections, to plan its purchase of sets and of "fill ins" and to develop systematically, its entire system of exchanges.

<div style="text-align:center">Respectfully submitted,</div>

April 6, 1917.   C. W. REEDER.

Mr. Reeder was requested to make specific recommendations on the subjects treated in this report.   This was done at the second business session.   In accordance with the recommendations of Mr. Reeder, the following actions were voted by the Academy:

1.   That fifty copies of each special publication of which copies are now on hand or which may be published in the future shall be given free to the author.   (It is understood that any copies already given shall count on this number.)

2.   That the library of the Ohio Academy of Science be turned over to the Ohio State University for incorporation in The Ohio State University General Library.

3.   That a special card catalog be kept of the books thus received by the Ohio State University Library from the Academy.

4.   That a suitable printed plate, to be paid for by the Academy, be put in the books given to the Ohio State University Library.

Report of the Committee on Legislation

An oral report was presented by the chairman, Dr. Mendenhall.   The report was received and the Committee continued.

Report of the Committee on the Ohio Journal of Science

No report was presented.   The question at issue has practically solved itself, and the general satisfaction with the present relations of the Academy and the Ohio Journal of Science renders further work by the committee unnecessary.

Report of Committee on Catalog of Scientific Journals

The following report was presented by Mr. Reeder, of the Ohio State University Library, for the Committee on Catalog of Scientific Journals.   The report was received and ordered filed.

The Committee on the Union List of Scientific Periodicals begs leave to submit the following report:

Twenty-one Ohio libraries are now pledged to assist in the union catalog.   Three additional libraries have agreed to join the movement during the past year—Cincinnati University, Kenyon College, and Otterbein College.   Of these co-operating libraries, complete or partial deposits have been made by nine, namely:

Case School of Applied Science.
Kenyon College.
Lloyd Library.
Municipal University of Akron.
Oberlin College.
Ohio Archaeological and Historical Society.
Ohio State University Library.
Otterbein College.
Wittenberg College.

All cards so far deposited, have been arranged in one alphabet, after each card has been marked to show the owner library. In order to ascertain the work done during the year by the co-operating libraries which had not made deposits, a request was sent to each one asking for a statement of progress. Following are excerpts from the replies received:

Adelbert College of Western Reserve—Beginning in October, an assistant has given about half-time to the preparation of the records. The periodicals of the Reference Department and the 000 numbers of the Circulating Department are practically completed, making about 350 titles. Work is now proceeding on the 100's.

Antioch College—The librarian expects to get the records completed within a reasonable time.

Cincinnati University—This library contains the exchange deposit of the American Association for the Advancement of Science. Not much, if anything, can be done on the records until the work eases up a little.

Cleveland Public Library—Cards for about 550 titles are ready. These are for such titles as happen to be catalogued or recatalogued, so nothing has been done along any special line.

Hebrew Union College—No progress has been made in the preparation of the records.

Miami University—The staff work has been interrupted by sickness and leaves of absence, so no progress whatever has been made.

Ohio State Library—The larger part of the records of periodicals has been corrected and brought down to date, so the deposit is nearly ready for submission.

Ohio University—Members of the staff have been away, so nothing has been done on the records.

Ohio Wesleyan University—Owing to lack of sufficient staff to give it attention, not much progress has been made. However, the list of cards has been prepared for the bound volumes down to J. It is barely possible that a special worker can be put on these records and complete them in the near future.

Toledo Public Library—Press of work has prevented progress on the records.

Young Men's Mercantile Library Association—Few of our magazine sets have ever been more than arranged on the shelves. Fifty-one sets have been shelf-listed and catalogued and cards for these will be forwarded within the near future. Thirty-four sets have been shelf-listed only and will be catalogued as time permits.

No word was received from the Cincinnati Public Library and Hiram College.

The Academy is aware that the College Section of the Ohio Library Association is co-operating in this work. A full and detailed report was made at its meeting on October, 1916. It was voted at that time to continue the compilation on the lines already laid down and rush the union list to completion as quickly as the time and resources of each individual library permitted.

However, a phase has developed to the Ohio situation which needs thorough consideration. The university libraries of the middle west have projected a Union List which is to include Nebraska, Minnesota, Wisconsin, Iowa, Illinois, Michigan, Ohio and the metropolitan districts of St. Louis and Chicago. The plans for this list have been laid by the H. W. Wilson Co., the estimates of printing made and the copy from nearly all the libraries is ready. Consideration is now being given to the time limit, so the publication may proceed.

Here are some problems for Ohio:

(1) Shall we ask for the inclusion of the Ohio Union list in the proposed "North Central List?"

(2) Is the Academy ready to finance the inclusion of its list, on the basis of what other co-operators will pay?

(3) If the Academy does not finance the proposition, shall we ask each library to finance its own contribution to such a list, or buy its quota of volumes?

(4) When the "North Central List" is published, will there be need for an exclusive Ohio List?

The committee recommends that, in spite of the complication of the situation, work be continued on the distinctively Ohio List and that the relation of the Ohio proposition to that of the universities of the Middle West be held in abeyance until many of the details of the larger union list are definitely settled.

C. W. Reeder.

April 6, 1917.

The following actions were voted by the Academy:

1. That the recommendations contained in the report of the Committee on Catalog of Scientific Journals be adopted.

2. That the Committee on Catalog of Scientific Journals be discharged, and that the work formerly done by this committee be transferred to the Library Committee.

Election of Officers

From the double slate of nominations prepared by the Nominating Committee, the following officers for 1917-18 were elected by the ballot of the Academy:

President—Professor F. L. Landacre, Ohio State University, Columbus.

Vice-President for Zoology—Professor C. G. Shatzer, Wittenberg College, Springfield.

Vice-President for Botany—Professor Freda Detmers, Ohio State University, Columbus.

Vice-President for Geology—Professor G. F. Lamb, Mt. Union College, Alliance.

Vice-President for Physics—Professor SAMUEL R. WILLIAMS, Oberlin College, Oberlin.

Vice-President for Anatomy, Physiology, etc.—Professor R. J. SEYMOUR, Ohio State University, Columbus.

Secretary—Professor E. L. RICE, Ohio Wesleyan University, Delaware.

Treasurer—Professor J. S. HINE, Ohio State University, Columbus.

Elective Members of Executive Committee—Professor C. G. SHATZER, Wittenberg College, Springfield; Professor FRANK CARNEY, Denison University, Granville.

Member of Publication Committee—Professor L. B. WALTON, Kenyon College, Gambier.

Trustee of Research Fund—Professor HERBERT OSBORN, Ohio State University, Columbus. (The resignation of Professor M. M. METCALF was presented, and the Chair was instructed to appoint a trustee to fill the vacancy until the next Annual Meeting. Chair appointed Professor M. E. STICKNEY, Denison University, Granville.)

Member of Library Committee—Professor F. O. GROVER, Oberlin College, Oberlin.

On nomination from the floor, the following were elected to represent the Academy on the editorial board of the Ohio Journal of Science:

Zoology—Professor R. A. BUDINGTON, Oberlin College, Oberlin.

Botany—Professor M. E. STICKNEY, Denison University, Granville.

Geology—Professor G. D. HUBBARD, Oberlin College, Oberlin.

Physics—Professor S. J. M. ALLEN, University of Cincinnati, Cincinnati.

Anatomy, Physiology, etc.—Professor F. C. WAITE, Western Reserve University, Cleveland.

Election of Members

The Membership Committee reported ten names for election to membership; one additional name, previously approved by the Executive Committee and marked with * in the following list, was presented for ratification. All were elected, as follows:

Brooks, Clyde, Physiology, Physiological Chemistry, Pharmacology, O. S. U., Columbus.

Cameron, Hazel C., Pathology, 1234 Highland St., Columbus.

*Eggleston, H. Ray, Botany, Zoology, Paleontology; Marietta College, Marietta.

Faulkner, Herbert C., Entomology, Biology; 2 Val. View Boulevard, Ashtabula.

Huber, H. E., Biology; Ohio Northern University, Ada.

Hugger, Carl Claron, Pathology; 710 N. Park St., Columbus.

Kisliuk, Max, Jr., Zoology, Entomology, Botany; Botany and Zoology Bldg., O. S. U., Columbus.

McCaughey, W. J., Mineralogy; Lord Hall, O. S. U., Columbus.

Orcutt, Ruth; Botany, Zoology; Granville.

Speaks, John C., Ichthyology, Ornithology; Columbus.

Yampolsky, Cecil, Botany, Zoology, Genetics; Toledo University, Toledo.

The Report of the Committee on Necrology

The following report was presented by the Committee on Necrology:

Not often does it fall to the Academy to record the loss of two leading members and past officers within one year.   Within three days, Sept. 11 and Sept. 14, there occurred the deaths of Professor Charles Smith Prosser and Professor William Rane Lazenby.   In many points their lives had run in similar ways; both born as farmer's sons in central New York, both graduates of Cornell University, both of necessity in part working their way through, both retained for a number of years by the University as assistants in their respective fields, both subsequently called to Ohio State University as heads of their respective departments, both loyal members of the Sigmi Xi, and both active through their entire scientific careers in painstaking research and conscientious teaching.

Professor Lazenby was born in 1850 at Bellona, N. Y.   He was graduated from Cornell University in 1874, at which time he won the Ezra Cornell prize in Agriculture.   He was Instructor in Horticulture and Botany, '74-'77 and Assistant Professor, '77-81 at Cornell; Professor of Botany and Horticulture, '81-'92, of Horticulture and Forestry, '92-'08, and of Forestry at Ohio State University from that date to his death.   He was founder and for five years director of the Ohio Experiment Station, an institution which has been a very important factor in the agricultural development of his adopted state.

He was an active member of many scientific organizations, among which are:

> American Association for the Advancement of Science (twice Secretary and once Vice-President of Section I);
> Society Horticultural Science;
> American Pomological Society;
> American Forestry Society (Vice-President many years);
> Society for Promotion of Agricultural Science (Secretary five years and President two years);
> Ohio Academy of Science (founder and President, '02);
> Ohio Forestry Society (President, '04 to date of his death).

His activity in these organizations grew out of a keen interest in them, their members and their ideals, an interest which expressed itself in wise counsel, frequent contributions to their programs, and discussions of the papers of others.

Teaching was his main business during the college year, but his summers were always spent in travel and investigation; several were spent in Europe, studying her forests and forestry methods.

His publications include many contributions both to Scientific Journals and State reports and to the semi-popular and popular press.

In the words of a close friend at Cornell: "While he found his great interest in life, the mastery and development of his special field in science, it was the human side of him that had the strongest hold on his friends and colleagues.   He never lost his interest in the struggles

of students with limited means, and in a quiet way extended aid to many of them. He never lost an opportunity for service to his friends or others in need; sympathy, helpfulness and loyalty were his characteristic qualities as a man and friend; and the loss to all of us who knew and loved him is irreparable."—J. H. Comstock, *Science*, December 29, 1916, p. 913.

Hundreds of students now scattered to all parts of the country have sat at his feet, and can testify to the quiet, unassuming scholarship and sympathetic instruction to which they were there exposed. Many have attained to eminence in horticulture and forestry through the working out of the interest and enthusiasm he engendered.

As a member of the Academy he was practically always at its meetings with an important contribution to make. His presentation was always interesting and plain. Continually alert for opportunities by which the Academy could serve the Commonwealth and Science, he became the channel through which we received our annual, financial aid for research from our loyal patron and life member, Mr. Emerson McMillin. He served on the trustee committee from 1901 to the time of his death and wisely discharged his duties.

If any difficult problem arose in the affairs of the Academy he was not lacking in efficient counsel nor was it hastily or injudiciously given. Thus we shall miss his thoughtfulness and wisdom.

Professor Prosser was born in 1860 at Columbus, New York. He was graduated from Cornell University in 1883, was a fellow one year and instructor to 1888; received his master's degree in 1886 and returned twenty years later and took his doctor's degree in 1907. One year before Union College gave him an honorary Doctorate of Science.

He was professor of Natural History at Washburn, Kansas, '92-'94, of Geology at Union, '94-'99, Associate Professor of Historical Geology, '99-'01 at Ohio State University and Professor and Head of the Department from then to the date of his death. For four years after leaving Cornell University he was Assistant Paleontologist on the U. S. Geologic Survey, Assistant Geologist '92-'95 and '00-'16. He was a member of the N. Y. Geological Survey, '95-'99; Kansas Geological Survey, '96, Chief Appalachain Division, Maryland Geological Survey, '98-'01; Assistant Geologist, Ohio Geological Survey, '00-'16.

He was a member of the leading Geological and Scientific Societies of America and of some foreign organizations, among which are the following:

International Congress of Geologists, London, 1888;
International Geographic Congress, New York, 1904;
Fellow American Association Advancement Science (Vice-President, Section E, at the time of his death);
Society of Naturalists;
Society of Vertebrate Paleontologists;
Geological Society of America;
Paleontological Society of America;
National Geographic Society;
Geologische Verein;
Washington, D. C., Kansas and Ohio Academies of Science.

While teaching was the chief business of Dr. Prosser during practically his whole public life, his vacations and all spare time during the school year were devoted to research.   He loved it and was willing to sacrifice much to attain his goals in his scientific career.

His contributions were always marked by most painstaking and precise accuracy in the fields they covered and thus left little for anyone else to do when he had finished.

Among his publications are extensive papers and reports on the geology and paleontology of New York, Maryland, Kansas, and Ohio. They are largely stratigraphic and paleontologic, and are particularly strong in the correlations which they set forth.

The State Geologist of New York, with whom Professor Prosser had long been associated, gives a beautiful estimate of him in the following words:

"There never was a more loyal, a more devoted, a more sensitive spirit.   His attitude of mind was puritanic in its simplicity and in its practices, and, left to himself he could never suspect another of indirectness or duplicity—a quality of which he contained not a grain.   When confronted by the broader bearings of his science and the natural sequences of its greater propositions, he held himself somewhat carefully aloof. Yet this simplicity of heart which would not let him go far afield, also made him extraordinarily conscientious in his scientific work. It would not be fair to him to say that he had a genius for details, but it would be eminently right to assert that he sought intimately and faithfully for the exact construction of every observation he made so far as that had to do with the theme in hand.   This mental method led him to a precision of manner and gave him a certain formality which was seldom dismissed under the most informal circumstances."— J. M. Clarke, *Science*, October 20, 1916, p. 559.

Many men and women have gone out from under his training, in Kansas, New York, and Ohio, who can trace their geological ideals and beginnings to him.   Some have attained to eminence in geologic and paleontologic research or in teaching and uphold the high standards to which he was devoted.

<div align="right">(Signed) Geo. D. Hubbard, Chairman,
Herbert Osborn.</div>

Report of the Committee on Resolutions

The following report was presented by the Committee on Resolutions, and adopted by the Academy.

1.   The Academy wishes again to express its gratitude for the continued generosity of Mr. Emerson McMillin, and to put on record its appreciation of the value of his gifts to the Research Fund in the stimulation and extension of research on the part of the membership of the Academy.

2.   The Academy desires to express sympathy for Professor F. O. Grover, whose illness, brought on by overwork, has prevented him from

attending and presiding as president at this meeting.   It is to be hoped that he may offer for publication the address he had expected to give.

3.   Professor Robert F. Griggs is entitled to the thanks of the Academy for his very interesting illustrated lecture on his recent "Explorations of Mount Katmai, Alaska."

4.   The thanks of the Academy are given to Professor James R. Withrow for his timely and valuable lecture on "The Relation of War to Chemistry in America."

5.   The Academy thanks the Local Committee and the Professors and Officers of the Ohio State University for providing convenient rooms for the general and sectional meetings and for their efforts in ministering to the comfort of all members in attendance.

6.   The Secretary of the Academy, Professor E. L. Rice, deserves much credit for making detailed arrangements for this successful meeting, although other duties have necessitated his absence from the State.

<div style="text-align: right">

E. L. MOSELEY,
L. B. WALTON,
C. G. SHATZER,
Committee.

</div>

Section for Physiology, Anatomy, Bacteriology and Pathology

A petition, signed by sixteen members, was presented, requesting the Academy to establish a new section for Physiology, Anatomy, Bacteriology, and Pathology—the exact name of the section to be determined later.

The petition was granted; and a vice-president and representative upon the Editorial Board of the Ohio Journal of Science were elected for the new section.

Constitution and By-Laws

The Acting President was instructed to appoint a committee of three to codify the Constitution and By-Laws. This committee was requested to consider the desirability of lengthening the terms of office of the president and secretary. (This action to be interpreted as notice of amendment, so that definite action may be taken at the next meeting.)

The Acting President appointed the following committee: Secretary E. L. Rice, ex-officio; F. C. Blake, Frank Carney.

The Academy directed the Executive Committee to print a new edition of the Constitution and By-Laws.

Time Limit for Papers

It was voted by the Academy that, in case titles of papers are sent in without specification of the time needed, a time limit of five minutes shall be set by the Program Committee.

Adjournment

The meeting adjourned without determining the place of the next meeting.

Scientific Sessions

The complete scientific program of the meeting follows:

Presidential Address

Some Aspects of Present Day Biological Unrest, F. O. Grover
(Omitted because of the absence of the President)

Lectures

The Relation of War to Chemistry in America,
James R. Withrow

Recent Explorations of Mount Katmai, Alaska,
Robert F. Griggs

Papers

1. Eskers in the Dayton Area. 20 min. (Lantern).........Aug. F. Foerste
2. The Preservation and Utilization of Wild Life in Ohio. 20 min.
Herbert Osborn
3. The Anatomy of an Eight-Legged Pig. 15 min. (Lantern),
Stephen R. Williams
4. The Origin of the "Reserve Cells" (Neoblasts) in the Regeneration of
Tubifex. 15 min. (Lantern).............................F. H. Krecker
5. Prospective and Retrospective Methodology in relation to the Problem
of Evolution. 15 min. (Lantern)............................L. B. Walton
6. Mutations by Interference:—A Study in Heredity. 12 min....A. B. Plowman
7. Drainage Developments in Southeastern Ohio. 20 min....Geo. D. Hubbard
8. Furs in the Wild and in the Shop. 20 min..... Katharine Dooris Sharp
9. A Suggested Method for the Distinctive Description of Dipterous
Larvæ. 7 min. .... C. L. Metcalf
10. Additional Records and New Species of Ohio Homoptera. 10 min.
Herbert Osborn
11. Some New or Interesting Insect Predators. 10 min ....C. L. Metcalf

Demonstrations

<div align="right">

Lewis G. Westgate,
Acting Sec'y during Meeting.

Edward L. Rice,
Secretary.

</div>

Date of Publication, November 30, 1917.

TABLE OF CONTENTS

THE ASTEREÆ OF OHIO.

EMERY C. LEONARD.

Mostly erect geophilous perennial or occasionally annual herbs with stems branching at the top or in a few cases scapose. Leaves alternate, sessile, petioled, or clasping. Flowers bisporangiate, carpellate, or staminate, on a common receptacle, forming heads subtended by an involucre of few to many bracts imbricated in one or more series. Pappus of capillary bristles, teeth, or scales, or sometimes wanting. Ray flowers present in most cases. Achenes glabrous or pubescent.

SYNOPSIS OF THE ASTEREAE.

I. With yellow ray flowers or with rays absent (white in Solidago bicolor).
    1. Pappus of scales, not capillary bristles   *Grindelia.*
    2. Pappus of capillary bristles with or without an outer series of shorter ones.
        a. Pappus double, an inner series of capillary bristles and an outer series
            of short ones; heads large.   *Chrysopsis.*
        b. Pappus a single series of capillary bristles; heads small.
            (1) Receptacle alveolate; rays mostly fewer than the disk flowers.
                                                                    Solidago.
            (2) Receptacle fimbrillate; rays more numerous than the disk flowers;
                heads in a corymbose paniculate inflorescence.   *Euthamia.*
II. Ray flowers present, not yellow but some shade of pink, blue, purple, white
    or greenish.
    1. Pappus a crown of awns or none, never of typical capillary bristles.
        a. Pappus none or a mere crown of minute bristles; receptacle conic. *Bellis.*
        b. Pappus a crown of few awns; receptacle flat or convex.   *Boltonia.*

2. Pappus of numerous capillary bristles.
    a. Pappus a single series of capillary bristles.
        (1) Bracts of the involucre two to many series.
            (a) Involucre narrow, its bracts firm; rays few, white.
                                                Sericocarpus.
            (b) Involucre turbinate or hemi-spherical, its bracts mostly thin; rays usually more numerous, white to purple.   *Aster.*
        (2) Bracts of the involucre mostly in one or two series; heads mostly long pedicled.
            (a) Rays longer than the disk flowers.   *Erigeron.*
            (b) Rays not longer than the disk flowers; heads very small, panicled.   *Leptilon.*
    b. Pappus distinctly double, the outer series shorter than the inner.
        (1) Leaves lanceolate-ovate to obovate; rays white.   *Doellingeria.*
        (2) Leaves narrowly linear; rays violet.   *Ionactis.*

<div align="center">KEY TO THE GENERA.</div>

1.   Ray flowers yellow.   2.
1.   Ray flowers not yellow.   5.
2.   Leaves punctate, linear or linear-lanceolate; heads small, corymbose, somewhat glutinous.   *Euthamia.*
2.   Leaves not punctate in our species.   3.
3.   Pappus in 2 series, the inner of long, the outer of short somewhat chaffy bristles; stem leaves entire.   *Chrysopsis.*
3.   Pappus of nearly equal bristles; leaves mostly serrate or dentate.   4.
4.   Pappus of 2–8 coarse deciduous bristles; heads large, sometimes glutinous.   *Grindelia.*
4.   Pappus of numerous capillary bristles; heads comparatively small, not glutinous.   *Solidago.*
5.   With single flowers on leafless scapes; pappus of the disk flowers none.   *Bellis.*
5.   Flowers on leafy stems, pappus present on the disk flowers.   6.
6.   Pappus of the disk flowers 2–5 scale-like bristles.   *Boltonia.*
6.   Pappus of the disk flowers of numerous capillary bristles.   7.
7.   Ray flowers 4–5.   8.
7.   Ray flowers numerous or rarely none.   9.
8.   Flowers in terminal cymose panicles.   *Sericocarpus*
8.   Flowers in crowded clusters forming a spike or thyrsus.   *Solidago* (bicolor).
9.   Pappus in a single series.   10.
9.   Pappus double, the outer series of short bristles.   11.
10.   Bracts of the involucre imbricate in several series.   *Aster.*
10.   Bracts of the involucre in but 1 or 2 series.   *Erigeron.*
11.   Ray flowers inconspicuous, white; annuals.   *Leptilon.*
11.   Ray flowers conspicuous.   12.
12.   Ray flowers 25–200, narrow, bracts of the involucre very narrow.   *Erigeron.*
12.   Ray flowers 8–15.   13.
13.   Rays white; leaves lanceolate to oblong, pinnately veined.   *Doellingeria.*
13.   Rays violet; leaves narrow, one nerved; peduncles covered with bracts.
                                               Ionactis.

Grindèlia Willd.   Gum-plant.

Coarse perennial or biennial herbs with smooth stems, branched above and sometimes woody below. Leaves alternate, sessile or clasping, mostly spinulous dentate. Heads either large and solitary at the ends of the branches; involucre hemispherical, its bracts with green points and imbricated in several series; ray and disk flowers yellow. Pappus of 2–8 deciduous bristles. Achems short and glabrous.

1. **Grindelia squarròsa** (Pursh) Dun. Broadleaf Gum-plant. An erect plant, 6 in.–2 ft. high. Leaves oblong to oblong-spatulate, obtuse, more or less clasping at the base, sharply spinulose dentate, $1\frac{1}{2}$–$1\frac{1}{2}$ in. long and $1\frac{1}{4}$–$1\frac{1}{2}$ in. wide. Heads $3\frac{1}{4}$–$1\frac{1}{4}$ in. broad, glutinous; involucral bracts linear-lanceolate; rays sometimes absent. In dry soil. June to September. Hamilton County. From the west.

Chrysópsis (Nutt.) Ell. Golden-aster.

Branching perennial or sometimes biennial wooly or hairy fall flowering herbs with alternate, sessile, entire or slightly serrate leaves. Heads rather large and generally solitary at the ends of the branches; involucre hemispherical, of linear bracts imbricated in several rows, the outermost being the shortest; both ray and disk flowers yellow; ray flowers carpellate; disk flowers bisporangiate or only staminate. Pappus double, the outer series of short chaffy scales, the inner series of long capillary bristles. Achenes flattened, oblong-linear or obovate, pubescent.

1. Leaves parallel-veined, lower stem leaves, elongate-linear, entire; involucre campanulate.   *C. graminifolia.*
1. Leaves pinnately-veined, lower stem leaves oblong-lanceolate, slightly serrate; involucre hemispherical.   *C. mariana.*

1. **Chrysopsis graminifòlia** (Mx.) Ell. Grassleaf Golden-aster. Slender pubescent plants corymbosely branched above. Leaves grasslike, shining, 3–5 nerved, entire, the basal leaves 4–12 in. long, $\frac{1}{3}$–$\frac{1}{2}$ in. wide, stem leaves smaller, the uppermost reduced to erect awl-shaped bracts. Heads several or numerous, about $\frac{1}{2}$ in. broad; bracts of the involucre glabrate. In dry soil. August to October. No specimens.

2. **Chrysopsis mariàna** (L.) Nutt. Maryland Golden-aster. Stout herbs 1–$2\frac{1}{2}$ ft. high, pubescent with silky hairs when young, becoming smooth with age, corymbosely branched above. Lower stem leaves oblanceolate to spatulate, narrowed into a petiole, 2–4 in. long and mostly 1 in. wide; upper leaves oblong to lanceolate, sessile, 1–2 in. long. Heads numerous, $\frac{2}{3}$–1 in. broad, on glabrous peduncles; bracts of the involucre acute, glandular, viscid-pubescent. Dry soil. August to September. Hocking, Jackson.

Solidàgo L.   Goldenrod.

Perennial herbs with simple or little branched stems, often somewhat woody at the base.   Leaves alternate, toothed or entire.   Some species with nodding tips.   Heads several in a terminal or axillary panicle, thyrsus, or cymose, corymbose or capitate cluster; involucre oblong or narrowly campanulate, of appressed bracts imbricated in several series, the outer successively shorter; both ray and disk flowers yellow or rarely white; disk flowers mostly bisporangiate, ray flowers sometimes carpellate.   Pappus of simple even capillary bristles.

KEY TO THE SPECIES.

1. Heads in axillary clusters, in a terminal spike-like thyrsus, in a typical thyrsus either with normal or secund branches; not flat-topped.   2.
1. Heads in a terminal corymbiform or thyrsoid cyme forming a flat-topped inflorescence.   20.
2. Heads in axillary clusters along the stem or the upper forming a spike-like or somewhat branched thyrsus.   3.
2. Heads in a terminal thyrsus or panical either simple or much branched, often secund.   8.
3. Involucre bracts with prominently spreading herbaceous tips.   *S. squarrosa.*
3. Involucre bracts without spreading tips, wholly appressed.   4.
4. Rays white; lower leaves mostly obtuse, more or less pubescent.   *S. bicolor.*
4. Rays yellow.   5.
5. Stem densely pubescent; ovulary glabrous.   *S. hispida.*
5. Stem glabrous or sparingly pubescent.   6.
6. Stem leaves broadly ovate, acuminate, sharply and coarsely serrate, sometimes glabrous; ovulary pubescent.   *S. flexocialus.*
6. Stem leaves lanceolate, or ovate-lanceolate.   7.
7. Stem leaves acuminate, lanceolate; ovulary pubescent.   *S. caesia.*
7. Stem leaves merely acute, broadly lanceolate or oblong-lanceolate; ovulary glabrous or nearly so.   *S. erecta.*
8. Heads in a slender more or less wand-like thyrsoid panicle, not secund on the branches or only slightly so; leaves not triple veined.   9.
8. Heads in a large usually dense panicle, secund on its slender or recurved branches.   11.
9. Inflorescence an oblong thyrsus; growing in bogs and on wet shores.   *S. uliginosa.*
9. Inflorescence a pyramidal or thyrsiform panicle with numerous erect racemes; upland species.   10.
10. Lower leaves ovate to broadly oval, serrate.   *S. speciosa.*
10. Lower leaves lanceolate to oblong-lanceolate, entire.   *S. rigidiuscula.*
11. Leaves triple nerved with a pair of lateral veins much stronger than the others.   12.
11. Leaves not triple nerved.   14.
12. Leaves rather narrowly lanceolate, the two lateral veins very prominent.   13.
12. Leaves oblanceolate or spatulate-oblong, the 2 lateral veins obscure; stem very pubescent at the base.   *S. nemoralis.*
13. Stem minutely pubescent above; involucre less than $\frac{1}{8}$ in. high. *S. canadensis.*
13. Stem glabrous throughout except in the inflorescence, often glaucous; involucre more than $\frac{1}{8}$ in. high.   *S. serotina.*
14. Stem densely pubescent; leaves more or less so.   15.
14. Stem glabrous or merely pubescent above.   16.
15. Leaves rugose-veiny beneath, sharply serrate, oval to oblong-lanceolate.   *S. rugosa.*
15. Veins not prominent; leaves sometimes more or less triple nerved, somewhat serrate, oblanceolate to spatulate-oblong.   *S. nemoralis.*

16. Leaves very rough on the upper surface, serrulate; stem strongly angled.
                                                                    S. patula.
16. Leaves minutely roughened on the upper surface; stems terete or nearly so. 17.
17. Main branches of the inflorescence few, usually leafy-bracted at the base,
    widely divergent, very slender.   *S. ulmifolia.*
17. Main branches of inflorescence numerous, rather crowded, spreading, recurved
    or ascending.   18.
18. Leaves firm, tapering gradually to the base, the uppermost chiefly entire. 18.
18. Leaves thin, the lower and middle stem leaves rather abruptly narrowed to a
    petiole; basal leaves mostly serrate.   *S. arguta.*
19. Leaves ovate-lanceolate or oblong-lanceolate; panicle usually longer than
    broad; rays 2–8.   *S. neglecta.*
19. Leaves lanceolate or oval-lanceolate; panicle usually as broad as high; rays
    8–12.   *S. juncea.*
20. Leaves ovate-oblong, mostly rough on both sides; flowers comparatively
    large.   *S. rigida.*
20. Leaves lanceolate or oblong-lanceolate, glabrous or nearly so; flowers com-
    paratively small.   21.
21. Leaves oblong-lanceolate, serrulate.   *S. ohioensis.*
21. Leaves lanceolate or narrowly lanceolate, entire.   *S. riddellii.*

1. **Solidago squarròsa** Muhl. Stout Goldenrod. Stem
stout, simple, or rarely branched, glabrous, mostly pubescent
above, 2–5 ft. high. Leaves glabrous or slightly pubescent, the
lower and basal ones ovate, oval, or broadly spatulate, acute or
obtuse, 1–4 in. wide; the upper leaves oblong, sessile, acute,
entire or slightly toothed. Heads numerous, in a narrow
terminal often leafy thyrsus, sometimes 12 in. long; rays 10–16,
showy; involucral bracts green with acute or obtuse, usually
strongly recurved tips. Achenes glabrous. In rocky soil.
August to September. Ashtabula, Lake, Cuyahoga.

2. **Solidago caèsia** L. Wreath Goldenrod. A plant with a
round, slender, glabrous, often glacous, blue or purplish stem,
branched or simple, 1–3 ft. high. Leaves lanceolate to oblong-
lanceolate, sessile, acuminate at the apex, narrowed at the base,
glabrous, sharply serrate, 3–5 in. long, $\frac{1}{4}$–$1\frac{1}{4}$ in. wide. Heads
in axiliary clusters or racemes, often forming a stout terminal
thyrsus; involucral bracts obtuse and appressed. Achenes
pubescent. Woods and thickets. August to October. General.

3. **Solidago flexicàulis** L. Zig-zag Goldenrod. Stem
glabrous, angled, zig-zag, usually simple. Leaves thin, ovate,
acuminate at the apex, narrowed at the base into margined
petioles, pubescent or glabrous beneath, sharply serrate, 2–7
in. long, 1–4 in. wide, the upper-most often lanceolate and
entire. Heads in stout axillary clusters or rarely in a narrow
terminal thyrsus; bracts of the involucre obtuse to acute,
appressed. Achenes hirsute-pubescent. In rich woods. July
to September. Eastern Ohio, as far west as Cuyahoga, Fair-
field, Jackson and Lawrence Counties; also in Ottawa County.

4.   **Solidago bícolor** L.   White Goldenrod.   Stem rather stout, hirsute-pubescent, sometimes glabrous, simple, or branched, $\frac{1}{2}$–4 ft. high.   The basal and the lower leaves obovate to broadly oblong, mostly obtuse, narrowed into long margined petioles, dentate to dentate-crenulate, sometimes pubescent, 2–6 in. long, 1–2 in. wide; the upper leaves smaller, oblong to lanceolate, often acute, mostly sessile and entire.   Heads crowded into a narrow terminal thyrsus, 2–7 in. long or clustered in the upper axils; involucral bracts whitish, obtuse; rays white.   Achenes glabrous.   In dry soil.   July to September. Columbiana, Geauga, Cuyahoga, Summit, Wayne, Erie, Fairfield, Vinton, Jackson, Lawrence.

5.   **Solidago híspida** Muhl.   Hairy Goldenrod. Stem densely pubescent or hirsute, simple or branched, $1\frac{1}{2}$–3 ft. high.   The lower and basal leaves oval, obtuse or acute, petioled, pubescent on both sides, mostly dentate, 2–5 in. long, 1–2 in. wide; the upper leaves smaller, oblong, sessile, acute, dentate or entire. Heads crowded in a dense terminal thyrsus, also often in racemose clusters in the upper axils; involucral bracts yellowish, obtuse.   Achenes with a few appressed hairs or glabrous. In dry soil.   August and September.   Ottawa, Lake.

6.   **Solidago erécta** Pursh.   Slender Goldenrod.   A slender rarely branched plant, 2–3 ft. high, glabrous or puberalent above. Leaves firm, glabrous on both sides; ciliolate on the margins; the lower and basal leaves oblong to oval, obtuse, crenate-dentate, the upper lanceolate to oblong lanceolate, acute and usually entire.   Heads in a narrow terminal thyrsus, sometimes with a few clusters in the upper axils; rays light yellow; bracts of the involucre obtuse.   In dry soil.   August–September.   Fairfield, Hocking, Meigs.

7.   **Solidago uliginòsa** Nutt.   Bog Goldenrod.   A rather stout plant with simple glabrous stem, 2–4 ft. high with the branches of the inflorescence somewhat pubescent.   Leaves oblong-lanceolate to lanceolate, firm, glabrous, mostly ciliolate or scabrous on the margins, few-veined, acute to acuminate, the lower and basal ones 4–9 in. long, $\frac{1}{2}$–$1\frac{1}{2}$ in. wide, somewhat serrate and narrowed into petioles; the upper, smaller, sessile and entire.   Heads in a terminal, oblong, dense thyrsus with appressed branches; bracts of the involucre linear-oblong, obtuse.   Achenes glabrous.   August–September.   In swamps and bogs.   Lucas, Portage, Stark, Wayne, Licking, Franklin.

8. **Solidago speciòsa** Nutt. Showy Goldenrod. Plants with stout stems, glabrous below and often rough above, 3–7 ft. high. Leaves firm and glabrous, the lower and basal ones ovate to broadly oval, 4–10 in. long, 1–4 in. wide, acute to obtuse at the apex and long petioled, dentate, pinnately–veined; the upper smaller, oblong to oval, acute at both ends, crenate-dentate or entire, sessile or short petioled, rough margined. Heads in a large terminal thyrsus of ascending, often leafy branches; bracts of the involucre oblong and very obtuse. Achenes glabrous or slightly pubescent. In rich woods. August–September. Lucas, Franklin, Fairfield and Lawrence.

9. **Solidago rigidiúscula** (T. & G.) Port. Slender Showy Goldenrod. Stem rather slender, glabrous below and rough pubescent above, simple, 2–4 ft. high. Leaves lanceolate to ovate-lanceolate, entire or the basal ones often crenate, strongly ciliolate on the margins, 1–5 in. long, $\frac{1}{4}$–1 in. wide, sessile or the lower often narrowed to petioles. Heads generally in a narrow dense, simple or branched thyrsus. In dry soil. August-October. Erie, Wyandot, Wood, Lucas, Fulton.

10. **Solidago rugòsa** Mill. Wrinkle-leaf Goldenrod. Stout scabrous hirsute plants, 1–7$\frac{1}{2}$ ft. high, simple or often branched at the top. Leaves scabrous or pubescent, oval, oblong-lanceolate or ovate-lanceolate, acute, acuminate or sometimes obtuse at the apex, narrowed or obtuse at the base, rugosely veined on the lower surface, serrate, 1–4 in. long, $\frac{1}{4}$–1$\frac{1}{2}$ in. wide, sessile or the lower tapering into petioles. Heads secund on spreading or recurving often leafy branches of usually a very large panicle; bracts of the involucre linear, obtuse. Achenes pubescent. In dry woods. July–November. Rather general.

11. **Solidago pátula** Muhl. Roughleaf Goldenrod. A stout rigid plant with usually a simple stem, glabrous below and very rough above, pinnate-veined; the lower and basal ones very large, 3–16 in. long, 1$\frac{1}{2}$–5 in. wide, oval to eliptical, narrowed to margined petioles; the upper similar, oval to oblong, sessile, acute, slightly serrate or entire. Heads secund on widely spreading and recurving branches of a loose panicle. Rays small; bracts of the involucre linear-oblong, obtuse. Achenes pubescent. In swamps. August to September. Rather general.

12.   **Solidago ulmifòlia** Muhl.   Elmleaf Goldenrod.   A very slender glabrous or puberulent plant, 2–4 ft. high, simple or with arched puberulent branches.   Leaves thin, oblong to eliptical-lanceolate, acute or acuminate at the apex and base, sharply serrate, pinnately veined, slightly pubescent, the lower and basal ones wider, 3–5 in. long, 1–1½ in. wide, narrowed to margined petioles, the upper smaller and sessile.   Heads secund on the usually few elongated and often leafy branches of the panicle; ray flowers small, deep yellow; bracts of the involucre oblong-lanceolate, obtusish.   Achenes pubescent.   In woods and copses.   July–September.   Rather general.

13.   **Solidago neglécta** T. & G.   Swamp Goldenrod.   Stem glabrous or slightly rough above, simple, rather stout, 2–4 ft. high.   Leaves firm, the lower and basal ones lanceolate to oblong-lanceolate, large, sometimes 12 in. long, acute, closely serrate or serrulate, tapering to margined petioles, rough on the margins; the upper smaller, lanceolate, acute, sessile, serrate or nearly entire.   Heads more or less secund on the short branches of the thyrsoid panicle; rays 3–8, small; bracts of the involucre thin, linear, obtuse.   Achenes glabrous or nearly so.   In swamps and bogs. August-September.   Wood, Madison, Fairfield.

14.   **Solidago júncea** Ait.   Plume Goldenrod.   Stem glabrous or nearly so throughout, rigid, rather stout, single or branched at the top, 1½–4 ft. high.   Leaves glabrous or rough, lanceolate to oval-lanceolate, acute to acuminate, serrate or entire, the upper ones smaller and sessile.   Heads secund on the recurved, branches of the usually spreading panicle; rays 7–12, small; bracts of the involucre oblong to ovate-oblong, obtuse or acute.   Achenes glabrous or sparingly pubescent.   In dry or rocky soil.   June–November.   Rather general.

15.   **Solidago argùta** Ait.   Cut-leaf Goldenrod.   Stem simple, rather stout, glabrous or sparingly pubescent above, 2–4 ft. high.   Leaves thin, pinnately veined, the lower and basal ones broadly ovate-oval, short-acuminate, 3–16 in. long, 1–5 in. wide, narrowed to margined petioles or subcordate, sharply and coarsely serrate; the upper leaves smaller, sessile, ovate to oblong, acute or acuminate, more or less serrate.   Heads secund on the lateral racemose branches of the terminal often leafy panicle; rays 5–7, large; bracts of the involucre oblong, obtuse.   Achenes glabrous or nearly so.   In rich woods.   July to October.   Erie County.

16. **Solidago canadénsis** L. Canada Goldenrod. Slender glabrous or pubescent plants, 1–5 ft. high. Leaves 3-nerved, linear-lanceolate, 2–5 in. long, $\frac{1}{4}$–$\frac{1}{2}$ in. wide, entire or serrate with somewhat appressed teeth, acuminate at the apex, narrowed at the base, sessile, or the lower petioled, glabrous or pubescent. Heads secund on the spreading branches of the often large panicle; rays 4–6, short; bracts of the involucre thin, linear, acutish. Achenes small and glabrous. Hillsides, thickets and banks of streams. August to October. General and abundant.

17. **Solidago serótina** Ait. Late Goldenrod. A stout glabrous often glaucous plant, 3–8 ft. high. Leaves lanceolate to oblong-lanceolate, thin, the lowest petioled, glabrous on both sides or pubescent beneath, more or less rough-margined, 3–6 in. long, $\frac{1}{8}$–$\frac{1}{4}$ in. wide, acuminate at the apex, narrowed at the base. Heads crowded on the spreading or recurved branches of the usually long leafy, often puberulent panicles; rays 7–15, rather large; bracts of the involucre oblong, thin and obtuse. Achenes finely puberulent. In moist soil. August to September. General.

18. **Solidago nemoràlis** Ait. Gray Goldenrod. A slender erect, or sometimes depressed and prostrate ash-gray plant, $\frac{1}{2}$–2 ft. high, finely and densely pubescent. Leaves thin, roughened, the basal and lower ones ovate-lanceolate or spatulate, petioled, obscurely triple-nerved, obtuse to acute, crenate-dentate, 3-6 in. long, $\frac{1}{3}$–1 in. wide; the upper becoming gradually smaller, oblanceolate or linear-oblong acute or entire; heads secund on the spreading or recurving branches of the terminal usually one-sided panicle; rays 5–9; bracts of the involucre linear-oblong. Achenes pubescent. In dry soil. July–November. General.

19. **Solidago rígida** L. Stiff Goldenrod. A stout simple or branched plant with densely and finely, pubescent, hoary stem, often becoming glabrous below with age. Leaves thick, flat, rigid, ovate to oblong, obtuse, pinnately veined, roughened on both sides or usually only beneath; the lower and basal long-petioled, sometimes 1 ft. long and 3 in. wide, entire or serrulate; the upper sessile, clasping and rounded or sometimes narrowed at the base, 1–2 in. long. Heads many-flowered, in a dense terminal compound corymb, the clusters sometimes slightly secund; rays 6–10, large; involucre broadly campanulate with oblong obtuse bracts, the outer ones pubescent. Achenes

glabrous, 10–15-nerved. In dry, gravelly, sandy, or rocky soil. August to October. Erie, Ottawa, Lucas, Defiance, Auglaize, Madison, Franklin, Lawrence.

20. **Solidago ohioénsis** Ridd. Ohio Goldenrod. A very smooth, simple-stemmed plant, 2–3 ft. high. Leaves firm, pinnately veined, flat; the lower and basal ones elongate-lanceolate, or oblong-lanceolate, obtuse, long-petioled, serrulate the end or towards entire, often 1 ft. long; the upper smaller; those of inflorescence often bract-like. Heads 15–25 flowered, numerous, in a terminal compound corymb; rays 6–9, small; bracts of the narrow campanulate involucre oblong, obtuse and glabrous. Achenes glabrous, 5-nerved. August to September. Stark, Erie, Wyandot, Franklin, Champaign, Clark, Montgomery.

21. **Solidago riddéllii,** Frank. Riddell's Goldenrod. A stout plant, glabrous or slightly pubescent above, 1–3 ft. high. Leaves numerous, thick, glabrous, entire, acute at each end; the lower and basal ones long-petioled, elongate, lanceolate, somewhat triple-nerved, conduplicate, often 1 ft. long, $\frac{1}{3}$–$\frac{7}{8}$ in. wide; the upper smaller, sessile, usually clasping at the base, conduplicate and somewhat falcate. Heads 20–30 flowered, numerous, in a dense corymb; rays 7–9, narrow; bracts of the oblong-campanulate involucre broadly oblong to obtuse. Achenes 5-nerved, glabrous. August to September. Lucas, Fulton, Wyandot, Franklin, Madison, Clark.

Euthàmia Nutt.   Fragrant Goldenrod.

Perennial herbs with corymbosely branched stems. Leaves linear to linear-lanceolate, entire, sessile, punctate, 1–5-nerved. Heads very numerous and small. Clustered in a large, corymbose, convex-topped inflorescence; bracts of the involucre obtuse, sometimes glutinous, appressed, imbricated in several series; ray-flowers carpellate and small; disk-flowers bisporangiate. Pappus of simple even capillary bristles. Achenes villous-pubescent.

1. Leaves distinctly 3–5-nerved; heads 20–27 or more flowered.   *E. graminifolia.*
1. Leaves 1-nerved, with a pair of indistinct lateral ones; heads rarely over 20-flowered.   *E. tenuifolia.*

1. **Euthamia graminifòlia** (L.) Nutt. Bushy Fragrant Goldenrod. A paniculately much branched or rarely simple plant, glabrous or roughish-pubescent, 2–4 ft. high. Leaves numerous, linear-lanceolate, acute to acuminate at both ends,

1–5 in. long, about $\frac{1}{3}$ in. wide, 3–5-nerved, rough pubescent on the margins and nerves of the underside. Heads sessile in glomerules, arranged in a flat-topped corymb; ray flowers 12–20; disk flowers 8–12; bracts of the ovoid-campanulate or subcylindrical involucre yellowish, oblong to oblong-lanceolate, slightly viscid. In moist fields and roadsides. July to September. General.

2. **Euthamia tenuifòlia** (Pursh) Greene. Slender Fragrant Goldenrod. Slender, glabrous, somewhat resinous plants, branched above, 2–4 ft. high. Leaves narrowly linear, entire, acuminate, sessile, narrow at the base, 1-nerved or with a pair of faint lateral nerves, punctate with minute resinous ducts, 1-16 – $\frac{1}{4}$ in. wide, with often smaller ones crowded in the axils. Heads in glomerules forming a dense nearly flat-topped corymb; rays 6–12; disk flowers 4–6; bracts of the oblong-campanulate involucre oblong. In dry, sandy soil. August to October. Erie, Lucas, Cuyahoga, Lake.

Béllis (Tourn) L. Daisy.

Tufted herbs with scapose or branched stems. Heads rather large and solitary at the ends of the scapes or branches, involucre hemispherical or broadly campanulate, of 1–2 series of nearly equal, imbricated, herbaceous bracts; ray flowers pink or white, carpellate; disk flowers yellow, bisporangiate. Pappus none or a ring of minute bristles.

1. **Bellis perénnis** L. European Daisy. Small plants with one or more naked pubescent scapes, 1–7 in. high. Leaves basal, obovate, obtuse, slightly dentate, 1–2 in. long, narrowed to margined petioles, pubescent and hirsute. Heads $\frac{1}{2}$–1 in. broad; ray-flowers numerous, linear, white, pink, or purple; bracts of the involucre oblong, obtuse and usually purple. In waste places and occasionally spontaneous on lawns. April to November. Lake, Cuyahoga. From Europe.

Boltònia L'Her. Boltonia.

Perennial herbs with striate or angled glabrous stems and alternate sessile, entire leaves. Heads rather large and numerous, paniculate or solitary on the ends of the branches. Involucre hemispherical or broadly campanulate, of scarious-margined bracts, imbricated in several series, the outer being somewhat shorter than the inner series; ray flowers carpellate;

disk flowers bisporangiate.   Pappus a series of short scales with
2–4 long bristles.

1.   **Boltonia asteroìdes** (L.) L'Her.   Boltonia.   A rather
stout plant, 2–8 ft. high.   Leaves lanceolate to oblong-lanceo-
late, sessile, 2–5 in. long, $\frac{1}{4}$–1 in. wide; the upper linear-lanceolate
and smaller.   Heads with white, pink, or purple rays; bracts
of the hemispherical involucre lanceolate to oblong-lanceolate,
acute or acuminate.   Pappus of small bristly scales, often with
2–4 slender bristles nearly as long as the achene.   Achenes
obovate to oval.   In moist soil.   July to September.   Erie,
Ottawa, Lucas, Auglaize, Paulding, Defiance.

Sericocàrpus Nees.   Whitetop Aster.

Perennial herbs with erect branching stems.   Leaves alter-
nate and sessile.   Heads rather small, in terminal cymose
panicles; involucre oblong-ovoid or campanulate, of coriaceous
bracts with herbaceous or squarrose tips, imbricated in several
series, the outer being the shorter, ray flowers white, carpellate;
disk flowers mostly bisporangiate, often purplish.   Pappus
of many capillary bristles, the outer often shorter.

1.   Leaves entire, linear, 3-nerved; stem striate, glabrous.   *S. linifolius.*
1.   Leaves dentate, ovate to oblong, pinnately veined; stem not striate, pubescent
    to glabrate.   *S. asteroides.*

1.   **Sericocarpus linifòlius** (L.) B. S. P.   Narrowleaf White-
top Aster.   Slender plants with glabrous striate stems 1–2$\frac{1}{2}$ ft.
high.   Leaves linear to linear-spatulate, spreading, scabrous
margined, faintly 3-nerved, thick, entire, obtuse at the apex,
narrowed at the base, 1–2 in. long, $\frac{1}{4}$ in. or less wide, sessile
or the lower on short margined petioles.   Heads clustered in
2's to 6's at the ends of the cymose branches; rays about $\frac{1}{2}$ in.
long; involucre about $\frac{1}{4}$ in. high, its bracts oblong, obtuse, the
outer with spreading green tips, the inner scarious, and often
ciliolate at the apex.   Pappus white.   In dry, usually sandy
soil.   June–September.   No specimens.

2.   **Sericocarpus asteroìdes** (L.) B. S. P.   Toothed Whitetop
Aster.   Stem pubescent or glabrate, slightly angled, 1–2 ft. high.
Leaves pubescent or glabrous, ciliate, pinnately veined, faintly
3-nerved; the basal ones obovate or spatulate, dentate or entire,
2–4 in. long, 1–1$\frac{1}{2}$ in. wide, narrowed to margined petioles; the
upper smaller, oblong-lanceolate, dentate or entire, acute or
obtuse.   Heads densely clustered in a rather loosely corymbose

inflorescence.   Involucre campanulate, its bracts oblong, ciliate, pubescent, the outer with green reflexed tips.   Pappus brown or white.   In dry woods.   July–September.   Cuyahoga, Summit, Wayne, Holmes, Fairfield, Hocking, Jackson, Gallia, Lawrence.

Aster L.   Aster.

Fall blooming herbs with branching stems, mostly perennial. Leaves alternate.   Heads of various sizes forming a corymbose or paniculate inflorescence; involucre hemispherical, campanulate, or turbinate, of various kinds of bracts, imbricated in several rows, the outer usually shorter; ray flowers white, pink, purple, blue, violet or rarely yellow; disk flowers bisporangiate, usually yellow, becoming brown or purple.   Pappus of numerous, slender bristles, scabrous or denticulate and mostly in one series.   Achenes mostly flattened and nerved.

KEY TO THE SPECIES.

 1. Lower stem and basal leaves cordate and definitely petioled.   2.
 1. None of the leaves cordate and definitely petioled.   12.
 2. Stem leaves cordate-clasping.   *A. undulatus.*
 2. Stem leaves petioled or sessile, not clasping.   3.
 3. Rays white.   4.
 3. Rays blue or violet.   5.
 4. Leaves thick, rough; inflorescence glandular.   *A. macrophyllus.*
 4. Leaves thin, smooth, inflorescence not glandular.   *A. divaricatus.*
 5. Plant not glandular.   6.
 5. Branches of the inflorescence glandular.   *A. macrophyllus.*
 6. Leaves entire or nearly so, thick and firm.   7.
 6. Leaves mostly sharply serrate, thin.   8.
 7. Leaves glabrous above or nearly so.   *A. shortii.*
 7. Leaves rough-pubescent on both sides; the upper bract-like.   *A. azureus.*
 8. Involucre ⅛–¼ in. high, bracts appressed, with conspicuously colored tips. 9.
 8. Involucre ¼–½ in. high, bracts loose, without conspicuously colored tips. 10.
 9. Cordate leaves mostly on smooth petioles, rough.   *A. cordifolius.*
 9. Cordate leaves mostly on winged petioles, smooth.   *A. lowrieanus.*
10. Heads loosely paniculate or subcorymbose.   *A. lindleyanus.*
10. Heads densely racemose-paniculate.   11.
11. Stem glabrous or nearly so.   *A. sagittifolius.*
11. Stem densely short pubescent.   *A. drummondii.*
12. Stem leaves or some of them with more or less clasping cordate bases, none of them both cordate and petioled.   13.
12. Stem leaves without cordate and clasping bases, sessile, or petioled.   22.
13. Stem rough or hirsute-pubescent.   14.
13. Stem glabrous or only sparingly pubescent above.   18.
14. Leaves or some of them serrate.   *A. puniceus.*
14. Leaves entire.   15.
15. Heads ½–1 in. broad; leaves large, slightly clasping.   *A. oblongifolius.*
15. Heads 1–2 in. broad; leaves strongly cordate and clasping.   16.
16. Branchlets of the inflorescence glandular viscid; involucre hemispherical. *A. novæ-angliæ.*
16. Branchlets of the inflorescence not glandular viscid; involucre turbinate.   17.
17. Leaves thick and firm, very rough, oblong to oval.   *A. patens.*
17. Leaves thin, roughish, oblong-lanceolate.   18.

18. Stem leaves sharply serrate. 19.
18. Stem leaves entire or nearly so. 21.
19. Leaves tapering to the base.   *A. puniceus.*
19. Leaves not tapering to the base. 20.
20. Leaves abruptly contracted into margined petioles, often enlarged at the base.
                                                                    A. prenanthoides.
20. Leaves strongly cordate clasping, bracts green tipped.   *A. lævis.*
21. Bracts of the involucre with rhomboid green tips.   *A. lævis.*
21. Bracts of the involucre narrow, not foliaceous, leaves narrowly linear.
                                                                    A. junceus.
22. Involucral bracts without green tips, leaves narrow, entire.   *A. paniculatus.*
22. Involucral bracts with green tips. 23.
23. Heads in more or less 1-sided racemes. 24.
23. Heads not in 1-sided racemes, mostly paniculate. 26.
24. Stem leaves oblong to lanceolate, serrate or mostly so. 25.
24. Stem leaves linear-lanceolate to linear, nearly entire; stem glabrate.
                                                                    A. vimineus.
25. Stem pubescent or glabrate.   *A. lateriflorus.*
25. Stem villous; leaves narrowly lanceolate, thin.   *A. hirsuticaulis.*
26. Involucral bracts appressed, acute. 27.
26. Involucral bracts spatulate, mostly ciliate, somewhat spreading, at least
        the outer obtuse; heads numerous.
                                                                    A. multiflorus.
27. Heads solitary at the end of very small leafy branches.   *A. dumosus.*
27. Heads paniculate. 28.
28. Stem leaves lanceolate, serrate or entire. 29.
28. Stem leaves linear-lanceolate to lanceolate, mostly entire. 31.
29. Heads $3\frac{1}{4}$–$7\frac{1}{8}$ in. broad. 30.
29. Heads $1\frac{1}{2}$–$3\frac{1}{4}$ in. broad, stem leaves narrowly lanceolate.   *A. tradescanti.*
30. Leaves firm, rough or roughish; rays often purplish; involucral bracts acute.
                                                                    A. salicifolius.
30. Leaves thin, smooth; rays chiefly white; involucral bracts acuminate.
                                                                    A. paniculatus.
31. Heads scattered, $1\frac{1}{2}$–$3\frac{1}{4}$ in. broad; the upper leaves linear.   *A. faxoni.*
31. Heads numerous, $1\frac{1}{4}$–$1\frac{1}{2}$ in. broad; the upper leaves subulate. 32.
32. Stem smooth; leaves linear-lanceolate.   *A. ericoides.*
32. Stem densely villous; leaves oblong-lanceolate to lanceolate.
                                                        A. ericoides var. *platyphyllus.*

   1. **Aster divaricàtus,** L. White Wood Aster. Tufted
plants with slender, assurgent, somewhat zig-zag stems, $1\frac{1}{2}$–$2\frac{1}{2}$
ft. high, becoming glabrate with maturity. Leaves thin,
ovate-lanceolate, serrate with sharp spreading teeth, acuminate
or acute at the apex and cordate at the base, on slender petioles;
inflorescence leaves smaller, ovate and acute. Heads $\frac{3}{4}$–1 in.
broad, in a flattish forked corymb of long slender divergent
branches; rays 6–9, linear, white; disk turning brown; bracts
of the involucre mostly obtuse, ciliate, with inconspicuous green
tips, the outer short and oblong, the inner linear. In open
woodlands and thickets, in rather dry soil. September–October.
Meigs, Franklin, Fairfield, Lorain, Erie.

   2. **Aster macrophýllus** L. Largeleaf Aster. Rough plants
from long, thick rootstocks; stems reddish, smooth, often
grandular-viscid in the inflorescence. 2–3 ft. high. Basal

leaves broad, cordate, with a large irregular sinus, thick, rough and harsh above; teeth broad curved and pointed, on long petioles; the upper leaves smaller and narrower, oblong, on short winged petioles; the uppermost sessile and acute. Heads about $\frac{1}{2}$ in. high on rigid thickened peduncles forming a broadly corymbose irregular inflorescence; rays often 16, lavender or violet, rarely pale; bracts of the involucre conspicuously green-tipped, the outer short-ovate, the inner elongated and linear, sometimes roseate tinged on the margins. In moderately dry soil, in shaded places. August. Rather general; no specimens from the southwestern counties.

3. **Aster shórtii** Hook. Short's Aster. Slender plants paniculately branched above, with smooth or roughish stems, 2–4 ft. high. Leaves thick, smooth above, minutely pubescent beneath; the lower and basal ones ovate to ovate-lanceolate, acute to acuminate at the apex, cordate at the base, dentate or entire, 2–6 in. long, 1–2 in. wide, on slender petioles; the upper leaves lanceolate, entire, rounded at the base, sessile or on short petioles; inflorescence leaves small and bract-like. Heads numerous, rays 10–15, linear, violet blue, $\frac{1}{2}$ in. or less long; bracts of the broadly companulate involucre linear, acute, pubescent, with green appressed tips, imbricated in several series. Pappus tawny. On banks and along edges of woods. September–October. From Franklin and Montgomery Counties southward; also in Lake and Ottawa Counties.

4. **Aster azùreus** Lindl. Azure Aster. Stem slender, stiff, rough, branched above, 1–4 ft. high. Leaves thick, entire, rough on both sides; the basal ones ovate to ovate-lanceolate, acute to obtuse at the apex, somewhat cordate at the base, on slender naked petioles; upper leaves tapering to short petioles or sessile, lanceolate or linear; inflorescence leaves reduced to small appressed bracts. Heads numerous; rays 10–20, bright blue; bracts of the turbinate involucre glabrous, linear-oblong, acute, imbricated in several series, with green appressed tips. Pappus tawny. Along borders of woods. August–October. Franklin, Wood, Fulton, Erie.

5. **Aster cordifòlius** L. Common Blue Wood Aster. Bushy much branched plants with glabrous or rarely pubescent stems, 1–5 ft. high. Leaves thin, rough, often with scattered hair above and on veins beneath; lower and basal ones ovate-cordate, on slender scarcely winged petioles 2–5 in. long; the

upper smaller, ovate-lanceolate, sessile or on short petioles. Heads numerous, small; rays 10–20, bracts of the turbinate or cylindrical involucre linear, obtuse, green-tipped, appressed. Woods and thickets. September–December. Rather general.

6. **Aster lowrieànus** Port. Lowrie's Aster. Glabrous branched plants 1–4 ft. high. Leaves thickish, firm, often greasy to the touch; the basal ones on slender petioles, ovate to ovate-lanceolate, mostly cordate, acute or obtusish, serrate or increased, 2–6 in. long; stem leaves ovate to oblong, often cordate, on winged petioles; the uppermost lanceolate. Heads rather few, loosely panicled; ray flowers light blue; bracts of the turbinate involucre obtuse, appressed. In woods. September to October. Lake, Cuyahoga, Auglaize, Fairfield, Hamilton.

7. **Aster lindleyànus** T. & G. Lindley's Aster. Glabrous or sometimes pubescent plants, usually stout, 1–6 ft. high and branched above. Leaves rather thick, glabrous or slightly pubescent on the lower veins; basal ones acute or acuminate to the apex, cordate at the base, sharply serrate, ovate, on slender naked petioles; upper leaves ovate to ovate-lanceolate, serrate or entire, sessile or with margined petioles; inflorescence leaves smaller, linear-lanceolate. Heads often few; rays 10–20, blue or violet; bracts of the broadly turbinate or hemispherical involucre lanceolate, acute, rather loosely imbricated, glabrous or nearly so, with green tips. Pappus white. In open places. August to October. Wayne, Franklin.

8. **Aster drummóndii** Lindl. Drummond's Aster. A stout finely and densely canescent plant, branched above and 2–5 ft. high. Leaves thin, ovate, acuminate, rough above and canescent below; the lower and basal ones cordate, on slender naked petioles, sharply toothed, 2–4 in. long; the upper cordate or rounded at the base, usually on margined petioles; those of the inflorescence smaller, sessile, entire or nearly so. Heads on racemose branches; rays 8–15, blue; bracts of the turbinate involucre linear, slightly pubescent, acute to acuminate, with green appressed tips. Pappus whitish. In dry soil, borders of woods and on prairies. September to October. Madison County.

9. **Aster sagittifòlius** Willd. Arrowleaf Aster. Stout or slender herbs, glabrous or slightly pubescent above, 2–5 ft. high, with a paniculate inflorescence of ascending branches. Leaves

thin, slightly glabrous or roughened above, glabrous or pubescent below, the lower and basal ones cordate or sagittate, ovate, lanceolate, sharply serrate, acuminate, 3–6 in. long, on slender naked or narrowly margined petioles; the upper lanceolate, sessile or on short margined petioles, serrate or entire; inflorescence leaves very small. Heads crowded and racemose; rays 10–15, light blue or purplish; bracts more or less glabrous with slightly spreading green tips. Pappus whitish. In dry soil. August to October. Rather general.

10. **Aster undulâtus** L. Wavy-leaf Aster. Plants with stiff, rough, pubescent stems, divergent above, 1–$3\frac{1}{2}$ ft. high. Leaves rough on both sides, pubescent beneath, dentate, undulate or entire, acute to acuminate, the lower and basal ones ovate, cordate, 2–6 in. long, on margined petioles; the middle ones ovate-lanceolate or oblong, with margined petioles dilated and clasping at the base; the upper sessile and clasping; those of inflorescence small and bract-like. Heads numerous and racemose, often secund on spreading branches; rays 8–15, pale blue to violet; bracts of the broadly turbinate involucre linear, oblong, pubescent, acute or acutish with appressed green tips. Pappus whitish. In dry soil. September to October. Wayne County.

11. **Aster pâtens** Ait. Late Purple Aster. Slender, rough, divergently branched plants, 1–3 ft. high. Leaves ovate-oblong to oblong-lanceolate, rough and somewhat rigid, strongly cordate or auriculate-clasping at the broad base, entire, acute, or the lowest obtuse, 1–3 in. long, those of the branches smaller and bract-like, the margins rough-ciliate. Heads 1 in. or more broad, solitary at the ends of the branches; rays 20–30, purplish or deep violet; bracts of the broadly turbinate involucre linear-oblong, finely pubescent and somewhat glandular, imbricated in several series, with spreading, green, acute tips. Pappus tawny. Achenes pubescent. In dry open places. August to October. Portage County.

12. **Aster phlogifòlius** Muhl. Thinleaf Purple Aster. Plants resembling Aster patens Ait. but usually taller. Leaves larger, lanceolate to oblong-lanceolate, thin or membranous, acuminate at the apex, auriculate-clasping at the base, roughish above, pubescent beneath, usually narrowed below the middle, often 6 in. long. Heads usually numerous, 1–2 in. broad, panicled or racemose on the branches of the inflorescence; rays numerous,

purplish-blue; bracts of the involucre lanceolate, glabrate, somewhat loose, with herbaceous tips.   In woods and thickets. August to September.   Wayne and Portage.

13.   **Aster nòvæ-ángliæ** L.   New England Aster.   Stout leafy plants with hispid, pubescent stems, corymbosely branched above.   Leaves lanceolate, entire, rather thin, acute, pubescent, 2–5 in. long, $\frac{1}{2}$–1 in. wide, clasping the stem by an auriculate or broadly cordate base.   Heads numerous, 1–2 in. broad, clustered at the end of the branches; rays 40–50, linear, violet purple, rarely pinkish, red or white; bracts of the hemispherical involucre linear-subulate, rather unequal, spreading, pubescent; more or less glandular viscid.   Pappus reddish-white.   Achenes pubescent.   In fields and swamps. August to October. General.

14.   **Aster oblongifòlius** Nutt. Aromatic Aster. Stem much branched, hirsute-pubescent, 1–2$\frac{1}{2}$ ft. high.   Leaves crowded, oblong to oblong-lanceolate, sessile by a broad partly clasping base, usually rigid, entire, acute or macronate at the apex, rough on both sides, rough-margined, stem leaves 1–2 in. long and $\frac{1}{4}$ in. or less wide; those of the branches smaller.   Heads 1 in. broad; corymbose on the divaricate or ascending branches; rays 20–30, violet purple, rarely rose-color; bracts of the hemispherical involucre much imbricated, glandular, aromatic, linear to linear-oblong, with green, acute, spreading tips. Pappus light brown.   Achenes hoary with gray pubescence. On prairies and bluffs.   August to October.   No specimens.

15.   **Aster puníceus** L.   Purple-stem Aster.   Stout reddish plants with hispid, rigid, hairy or glabrous stems, corymbosely branched above, 3–8 ft. high.   Leaves lanceolate to oblong-lanceolate, acuminate, sessile, sharply serrate or entire, usually rough above, pubescent on the midrib or glabrous rough above, pubescent on the midrib or glabrous beneath, 3–6 in. long, $\frac{1}{2}$–1$\frac{1}{2}$ in. wide.   Heads usually many, 1–1$\frac{1}{2}$ in. broad; rays 20–40, violet, purple or pale, rarely white, showy; bracts of the hemispherical involucre linear-oblong, alternate, imbricated in about 2 series, glabrous or ciliate, green, loose, spreading, nearly equal, sometimes broadened.   Pappus nearly white.   Achenes pubescent.   In swamps.   July to November.   Rather general.

16.   **Aster prenanthoìdes** Muhl.   Crooked-stem Aster. Flexous much-branched plants with the stem glabrous or pubescent in lines above, 1–2 ft. high.   Leaves thin, oblong to ovate-lanceolate or lanceolate, sharply and coarsely serrate,

scabrous above, glabrous or nearly so beneath, 3–8 in. long, $\frac{3}{4}$–$1\frac{1}{2}$ in. wide, acuminate at the apex, abruptly narrowed below to a broad margined entire petiole with an auriculate clasping base. Heads usually numerous, 1 in. or more broad; rays 20–30; violet; bracts of the hemispherical involucre acute, green, spreading, imbricated in 3–4 series, the outer shorter. Pappus tawny. Achenes pubescent. August to October. In moist soil. Rather general.

17. **Aster laèvis** L. Smooth Aster. Stem usually stout, glabrous and often glaucous, 2–4 ft. high, branched or simple. Leaves entire or serrate, glabrous, slightly roughened on the margins, the basal and lower gradually narrowed to winged petioles, the upper sessile and usually clasping, lanceolate, oblong-lanceolate or ovate, acute or obtusish at the apex, 1–4 in. long, $\frac{1}{4}$–2 in. wide; those of the branches small and bract-like. Heads usually numerous, about 1 in. broad, in a close panicle; rays 15–30, blue or violet; bracts of the campanulate involucre rigid, ovate, appressed, green-tipped, imbricated in several series. Pappus tawny. Achenes glabrous or nearly so. Usually in dry soil. September to October. Rather general.

18. **Aster júnceus** Ait. Rush Aster. Very slender simple or little branched herbs with stems glabrous or pubescent above, 1–3 ft. high. Leaves firm, glabrous, roughish margined, entire, or with a few distinct teeth, acute to acuminate at the apex, sessile by a broad clasping or slightly cordate base, 3–6 in. long, $\frac{1}{8}$–$\frac{1}{4}$ in. wide. Heads about 1 in. broad, rather distant, paniculate; rays violet to white; involucre hemispherical, its bracts glabrous, linear, very acute, imbricated in 3–4 series, the outer shorter. Pappus pale. In swamps and bogs. July–September. Licking, Wayne.

19. **Aster lateriflòrus** (L.) Britt. Starved Aster. Stem pubescent or nearly glabrous, slender, divergently branched, 1–5 ft. high. Basal leaves ovate, slender petioled; stem leaves broadly lanceolate, or oblong lanceolate, acuminate, serrate, 2–5 in. long, $\frac{1}{2}$–1 in. wide; leaves of the branches smaller, oblong to linear-oblong. Heads $\frac{1}{3}$–$\frac{1}{2}$ in. broad, usually numerous, crowded short pedicled or sessile, arranged on the branches in onesided racemes; rays numerous, short, white or pale; disk flowers purple; bracts of the turbinate involucre obtuse to acutish, imbricated in about 4 series, with short, green, appressed

or with slightly spreading tips. Pappus white. Achenes slightly pubescent. In dry or moist soil. August to October. Rather general.

20. **Aster hirsuticaùlis** Lindl. Rough-stem Aster. Stem slender, erect, $1\frac{1}{2}$–3 ft. high, pubescent nearly to the base. Leaves thin, glabrous above, usually pubescent on the midvein beneath, serrate, with a few appressed teeth, or entire, linear-lanceolate to lanceolate, often 6 in. long, $\frac{1}{8}$–$\frac{1}{2}$ in. wide, the sessile or basal ones spatulate and petioled. Heads more or less unilateral on the branches, densely or loosely clustered or sometimes few in the axils of the leaves; rays white; bracts of the involucre linear-lanceolate, acute or acuminate, imbricated in 3–4 series. In woods and thickets. August to October. Warren, Auglaize.

21. **Aster vimíneus** Lam. Small White Aster. Slender bushy plants, divergently branched above, 2–5 ft. high. Stem leaves linear-lanceolate, entire or with a few fine sharp teeth in the middle, 3–5 in. long, $\frac{1}{8}$–$\frac{1}{4}$ in. wide, acuminate at the apex, narrowed to a sessile base; leaves of the branchlets much smaller. Heads very numerous, small, usually densely racemose-secund and short pedicled; rays numerous, white to purplish; bracts of the broadly turbinate involucre linear, acute, green-tipped, imbricated in 3 or 4 series. Pappus white. In moist soil. August to September. Wayne County.

22. **Aster multiflòrus** Ait. Dense-flowered Aster. A much branched, bushy plant, rough pubescent or scabrous, 1–7 ft. high. Leaves rigid, sessile or slightly clasping, rough, ciliate; those of the stem $\frac{1}{2}$ to $1\frac{1}{2}$ in. long; those of the branches very small and crowded. Heads densely crowded, nearly sessile and often slightly secund on the branches; rays 10–20, white; involucral bracts coriaceous, ciliate or pubescent, imbricated in 3 or 4 series, with green obtuse or mucronate spreading tips. Pappus brownish. Achenes puberulent. In dry open places. August–November. Lucas, Erie, Gallia.

23. **Aster dumòsus** L. Bushy Aster. Glabrous or nearly so throughout, rather stiff and viscid, usually paniculately branched, 1–3 ft. high. Leaves firm; the basal ones spatulate, dentate; those of the stem, linear to linear-lanceolate, entire, acute or obtuse, 1–3 in. long, $\frac{1}{8}$–$\frac{1}{4}$ in. wide, roughish margined, often reflexed, those of the branches very numerous, small and bract-like. Heads terminating the minutely leafy branches

and branchlets, usually numerous; rays 15–20, blue to pale violet or white; bracts of the broadly campanulate involucre linear subulate, obtuse or acutish, appressed, green-tipped imbricated in about 4 series. Pappus white. Achenes pubescent. Sandy soil. August–October. Erie County.

24. **Aster salicifòlius** Lam. Willow Aster. A rather slender paniculately much branched, leafy plant, 2–5 ft. high, glabrous, roughish or pubescent above. Leaves firm, lanceolate to linear-lanceolate, roughish or rough margined, acute at the apex, sessile or slightly clasping at the base, entire or sparingly dentate, glabrous or nearly so. 2–4 in. long, $\frac{1}{8}$–$\frac{1}{2}$ in. wide, the lower sometimes petioled; those of the branches smaller. Heads numerous; rays numerous, violet, violet purple or sometimes white; bracts of the involucre linear-oblong, appressed, imbricated in 4–5 series, with acute or obtusish tips. Pappus white. Achenes pubescent. In moist soil. August–October. Wayne County.

25. **Aster paniculàtus** Lam. Panicled Aster. A paniculately much branched plant with a glabrous or sometimes pubescent stem, 2–8 ft. high. Leaves lanceolate to linear-lanceolate, acuminate at the apex narrowed to a sessile or slightly clasping base, glabrous, roughish-margined; those of the stem slightly serrate or entire, 3–6 in. long, $\frac{1}{4}$–$\frac{1}{2}$ in. wide; the upper branch leaves gradually smaller. Heads numerous; rays numerous, white or faintly tinged with violet; bracts of the involucre linear-lanceolate, acuminate, appressed, green-tipped and imbricated in 4–5 series. Achenes minutely pubescent. In moist soil. August to October. General.

26. **Aster tradescánti** L. Tradescant's Aster. Stems slender, paniculately branched, 2–5 ft. high; the branches often pubescent in lines. Stem leaves linear-lanceolate to lanceolate, acuminate at the apex, narrowed to a sessile base, 3–6 in. long, $\frac{1}{8}$–$\frac{1}{2}$ in. wide, glabrous or nearly so on both sides, sharply serrate at the middle, or entire. Heads numerous and racemose on the branches; rays numerous, white or nearly so; bracts of the hemispherical involucre linear, acute, appressed, green-tipped, imbricated in 4–5 series. Pappus white. Achenes minutely pubescent. In fields and swamps. August to October. Rather general.

27. **Aster fáxoni** Porter. Faxon's Aster. A rather stout glabrous plant, paniculately or corymbosely branched, $\frac{1}{2}$–5 ft.

high.   Basal leaves oblong to spatulate, obtuse, dentate or entire; stem leaves lanceolate to linear-lanceolate, acute or acuminate at the apex, narrowed to a sessile base or a margined petiole, mostly entire, 2–5 in. long, $\frac{1}{8}$–$\frac{3}{8}$ in. wide, those of the branches gradually smaller.   Heads rather few; rays numerous, bright white or rarely purplish; bracts of the hemispherical involucre linear-lanceolate, acute, green-tipped, imbricated in about 3 series, the outer shorter.   Pappus white.   Achenes minutely pubescent. On moist cliffs. August–September. Vinton County.

28.   **Aster ericoìdes** L.   White Heath Aster. Usually bushy paniculately branched plants with glabrous or hirsute stems, branchlets often secund.   Leaves firm; the basal ones spatulate, obtuse, dentate, narrowed to margined petioles, glabrous or ciliate; stem leaves linear to linear lanceolate, acute entire, 1–3 in. long, $\frac{1}{8}$–$\frac{1}{4}$ in. wide; those of the branches bractlike and numerous.   Heads very numerous; rays 15–25, white or tinged with rose, bracts of the campanulate or hemispherical involucre coriaceous, lanceolate, abruptly acute, green-tipped, imbricated in about 3 series.   Pappus white.   Achenes finely pubescent. In dry soil.   September to December.   General.

var. **Aster ericoides platyphyllus,** T. & G.   A broad-leaved densely villous relative of Aster ericoides found in the western half of the state, east to Erie, Franklin and Meigs Counties.

29.   **Aster ptarmicoìdes** (Nees.) T. & G.   Upland White Aster.   Slender tufted plants with rigid corymbosely branched stems, usually rough above, 1–2 ft. high.   Leaves linear-lanceolate, 1–3 nerved, entire or with a few distant teeth, firm, shining, rough margined, acute, narrowed to a sessile base, or the lower petioled; the lower leaves 3–6 in. long, $\frac{1}{8}$–$\frac{1}{3}$ in. wide; the upper smaller and bract-like, $\frac{3}{4}$–1 in. broad; rays 10–20, white, bracts of the involucre linear oblong, obtuse, the outer acutish, appressed, nearly glabrous, green, imbricated in about 4 series. Pappus white.   Achenes glabrous.   In dry or rocky soil.   July to September.   (Ottawa County—Moseley Herbarium).

Erígeron L.   Fleabane.

Branching or scapose herbs with alternate or basal leaves. Heads solitary or in a naked corymbose pedunculate inflorescence, some species with nodding tips. Involucre hemispherical, cylindrical or campanulate, of narrow equal bracts imbricated in several series; ray flowers white or pink, bispor-

angiate; disk flowers yellow and bisporangiate. Pappus of slender scabrous or denticulate bristles in one series or sometimes a shorter additional outer series.

1. Heads 1–1½ in. broad, few; stem simple, pubescent.   *E. pulchellus.*
1. Heads ½–1 in. broad, many; stem branched.   2.
2. Rays 100–150, mostly purple or violet.   *E. philadelphicus.*
2. Rays considerably less than 100, white, sometimes purple tinged.   3.
3. Stem leaves linear lanceolate, the upper entire, the lower seomwhat dentate.
        E. ramosus.
3. Stem leaves lanceolate, all but the extreme upper ones sharply serrate. *E. annus*

1. **Erigeron pulchéllus** Mx. Showy Fleabane. Slender simple villous plants, perennial by stolons and offsets, 10–24 in. high. Basal leaves tufted, spatulate or obovate, somewhat wedgeshape at the base, narrowed into slender margined petioles, obtuse at the apex, 1–3 in. long, ½–2 in. wide, dentate, stem leaves partly clasping, oblong, lanceolate or ovate, acute, entire or slightly serrate. Heads 1–6, on slender peduncles; rays numerous, white or purple, ⅓–½ in. long; bracts of the depressed hemispherical involucre linear, acuminate, villous. Pappus simple. Achenes nearly glabrous. On hills and banks. April to June. General.

2. **Erigeron philadélphicus** L. Philadelphia Fleabane. Slender, soft pubescent or sometimes nearly glabrous plants, with nodding heads, perennial by stolons and offsets, mostly branched above, 1–3 ft. high. Basal and lower leaves spatulate or obovate, dentate, obtuse at the apex, narrowed to short petioles, 1–3 in. long; the upper stem leaves clasping, obtuse or acute, often clasping at the base, entire or sometimes dentate. Heads several or numerous, ½–1 in. broad, on the slender peduncles of a corymbose, paniculate inflorescence, the peduncles thickened at the summit; rays 100–150, light rose purple to pinkish; bracts of the depressed hemispherical involucre linear and mostly scarious margined. Pappus simple. Achenes pubescent. In fields and woods. April to August. General.

3. **Erigeron ánnus** (L.) Pers. White-top Fleabane. Annual erect corymbosely branched plants sparingly pubescent with spreading hairs, 1–4 ft. high. Leaves thin; the lower and basal ones ovate to ovate-lanceolate, obtuse, petioled, usually coarsely dentate, 2–6 in. long, 1–3 in. wide; the upper sessile or short-petioled, oblong to linear-lanceolate, acute or acuminate, sharply dentate at the middle, those of the branches narrow and often entire. Heads rather numerous, ½–¾ in. broad,

short peduncled; rays 40–70, linear, white or commonly tinged with purple, bracts of the hemispherical involucre hispid. Pappus double, the inner a series of slender fragile deciduous bristles, often wanting in the disk flowers, the outer a persistent series of short partly united scales.   In fields.   May to November.   General.

4.   **Erigeron ramòsus** (Walt.) B. S. P.   Daisy Fleabane. A plant resembling Erigeron annus but often lower and the pubescence more appressed.   Basal and lower leaves spatulate, usually serrate; stem leaves linear-oblong to linear-lanceolate, mostly entire.   Rays white or purplish, sometimes minute or wanting; bracts of the involucre glabrous or nearly so.   In fields.   May–November.   General.

Léptilon Raf.   Horseweed.

Annual or biennial herbs.   Heads small, in a racemose, or paniculate inflorescence.   Involucre campanulate, of narrow bracts imbricated in 1–2 series.   Ray flowers carpellate, white, shorter than the disk flowers.   Disk flowers bisporangiate. Pappus of numerous bristles, in 1 series.

1.   **Leptilon canadénse** (L.) Britt.   Common Horseweed. Erect wand-like plants with leafy hispid-pubescent or glabrate stems, 3–10 ft. high, the larger plants much branched.   Leaves often pubescent or ciliate, the basal and lower ones spatulate, petioled, incised, dentate or entire, 1–4 in. long, obtuse to acute; stem leaves linear, mostly entire.   Heads usually numerous, about $\frac{1}{8}$ in. broad; rays numerous, white, shorter than the pappus; involucre campanulate, its bracts linear, acute, glabrate, the outer shorter.   In fields and waste places. June–November. General.

Doellingèria Nees.   Flat-top Aster.

Perennial, branching, leafy herbs.   The upper leaves large, mostly entire, acute or acuminate; lower leaves much reduced; basal leaves none.   Heads numerous, in a corymbose inflorescence; involucre campanulate to hemispherical, of thin appressed, often scarious margined bracts imbricated in several series; ray flowers carpellate, white and not very numerous; disk flowers bisporangiate, white to greenish.   Pappus double, the outer of short bristles, the inner of long capillary bristles.

1.   Stem leaves lanceolate to ovate; heads mostly numerous.   *D. umbellata*
1.   Stem leaves obovate, heads commonly few.   *D. infirma.*

1.   **Doellingeria umbellàta** (Mill.) Nees.   Tall Flat-top Aster.   Corymbosely branched plants with striate stems, glabrous or pubescent above, 1–8 ft. high.   Leaves lanceolate to oblong-lanceolate, ascending, glabrous above, pubescent on the veins beneath, membramous, acuminate at the apex, short petioled at the base, stem leaves 5–6 in. long, $\frac{1}{2}$-1 in. wide; the upper leaves sessile, hispid-margined.   Heads numerous, in terminal compound corymbs; rays 10–15, white; bracts of the broadly campanulate or hemispherical involucre lanceolate, usually pubescent, ovate, often imbricated in 3–4 series, the outer shorter.   Pappus usually white.   Achenes slightly pubescent.   In moist soil.   July–October.   Rather general.

2.   **Doellingeria infírma** (Mx.) Greene.   Infirm Flat-top Aster.   Slender sparingly branched plants with round glabrous or roughish stems, $1\frac{1}{2}$–3 ft. high.   Leaves entire, hispid-margined, glabrous above, sparingly hispid on the veins beneath, the lower obovate, small, obtuse, usually sessile, the upper larger, oblong-lanceolate acute, 2–5 in. long, 1–$1\frac{1}{2}$ in. wide. Heads few, about 1 in. broad, in a spreading corymbose cluster; rays 8–15, white; bracts of the broadly campanulate involucre oblong-lanceolate, obtuse, sparingly pubescent, imbricated in about 4 series.   Pappus tawny.   Achenes nerved and glabrous. In dry, usually rocky soil.   August to September.   Portage County.

Ionáctis Greene.   Stiffleaf Aster.

Low branching perennial herbs.   Stem leaves numerous, narrow, entire, the basal ones none.   Heads rather large and showy, terminating the stem and branches; involucre of appressed coriaceous bracts imbricated in several series; ray-flowers carpellate, violet; disk flowers violet.   Pappus double, the inner of long capillary bristles, the outer shorter.

1.   **Ionactis linariifòlius** (L.) Greene.   Stiffleaf Aster.   Very leafy corymbosely branched plants with stiff tufted puberulent or scabrous stems, $\frac{1}{2}$–2 ft. high.   Leaves linear or spatulate, spreading, one nerved, mucronate at the apex, $\frac{3}{4}$–$1\frac{1}{2}$ in. long, about $\frac{1}{8}$ in. wide, sessile, those of the branches much smaller and somewhat appressed.   Heads several, about 1 in. broad, terminating the branchlets; rays 10–15, violet, rarely white, with entire, dentate, or laciniate tips; bracts of the broadly

turbinate involucre linear-lanceolate, keeled, green on the back, appressed, imbricated in 4–5 series, the inner obtuse, the outer acute. Pappus bristles in two series, tawny. Achenes silky. In dry or rocky soil. July to October. Adams, Hocking.

SOME OHIO HETEROPTERA RECORDS.

W. S. Adkins,
Department of Anatomy, University of Illinois, Chicago.

I am under obligations to Mr. W. J. Gerhart for the use of his collection and for other assistance; Mr. H. H. Knight has kindly determined some of the Miridæ; and my thanks are due to Miss Mildred M. Constiner for assistance in collecting. The year is 1917 when not otherwise stated.

Family Scutellerid.e.

Thyreocoris nitiduloides (Wolff). Springfield, August 11.

Thyreocoris pulicarius (Germar). Springfield, August 11; Yellow Springs, August 14.

Family Pentatomid.e.

Peribalus limbolarius Stal. Lagonda, August 16; Springfield, August 18; Trenton, September 26; Cincinnati, May 3.

Trichopepla semivittata (Say). Cincinnati, May 3; Springfield, August 20.

Mormidea lugens (Fabr.). Springfield, August 11, 13, 22 (grasses).

Euschistus euschistoides (Voll.) Springfield, August 15 (nymph) 17, 23 (on catnip), June 18, 1916; Trenton, September 15, 16, 27 (nymphs).

Euschistus tristigmus (Say). Springfield, August 14-15 (nymphs abundant).

Euschistus variolarius (P. B.) Springfield, August 11-26; Lagonda, August 16; Springfield, June 18, 1916; Cincinnati, May 3 (mullein). Trenton, September 26.

Coenus delius (Say). Yellow Springs, August 12 (spearmint).

Hymenarchys nervosa (Say). Springfield, June 18, 1916.

Neottiglossa sulcifrons (Stal). Springfield, August 11.

Cosmopepla bimaculata (Thomas). Springfield, June 18, 1916, July 15, August 11-25; nymphs abundant on mullein and various labiatæ, August 13.

Thyanta custator (Fabr.) Trenton, May 25 (on mullein).

Acrosternum hilaris (Say). Springfield, August 15 (nymphs, on blackberry); Clifton, August 22, 1915; Trenton September 25.

Banasa dimidiata (Say). Clifton, August 18 (on wild grape).

Podisus maculiventris (Say). Trenton, September 15.

Family CoreidÆ.

Acanthocephala terminalis (Dall.) Springfield, August 13, (grasses); August 15 (nymphs, blackberry).

Anasa tristis (De Geer). Trenton, October 1.

Megalotomus 5-spinosus (Say). Springfield, August 15.

Alydus pilosulus H. S. Springfield, August 13; Trenton, September 16.

Harmostes reflexulus (Say). Springfield, August 11-25.

Corizus lateralis (Say). Lagonda, August 20; Springfield, August 11-24; Yellow Springs, August 12 (on smartweed and Malva rotundifolia); Trenton, September 15, 23.

Family NeididÆ.

Jalysus spinosus (Say). Springfield, August 15.

Family LygÆidÆ.

Oncopeltus fasciatus (Dall.) Springfield, June 18, 1916 (Asclepias syraica).

Lygaeus kalmii Stal. Springfield, August 16, 25; June 18, 1916 (milkweeds).

Ortholomus longiceps (Stal). Springfield, August 16.

Geocoris uliginosus (Say). Trenton, September 23.

Phlegyas annulicornis Stal. Springfield, August 11-24.

Oedancala dorsalis (Say). Springfield, August 13, 15; Yellow Springs, August 12-14.

Myodochus serripes Oliv. Springfield, August 16.

Family PhymatidÆ.

Phymata erosa (Linn.) Springfield, August 13-20; Yellow Springs, August 14; Trenton, September 12.

Phymata erosa var. **wolfii** Stal. Springfield, August 13-22; Yellow Springs, August 14; Trenton, September 12, 26.

Family REDUVIIDÆ.

Acholla multispinosa (De Geer). Springfield, August 11, 13, 20, 22; Yellow Springs, August 14; Clifton, August 22, 1915; Trenton, September 15; nymphs and adults on elms and other shrubbery, Snyder Park, Springfield, August 11-25.

Sinea diadema (Fabr.) Springfield, August 11-25 (nymphs); Trenton, September 15 (nymph, alfalfa), 16 (nymph, ragweed).

Family ANTHOCORIDÆ.

Triphleps insidiosus (Say). Springfield, August 15-16.

Family MIRIDÆ.

Miris dolobratus (Linn.) Springfield, June 18, 1916; July 17; Yellow Springs, June 6, 1916, August 12 (grasses).

Stenodema trispinosum Reut. Springfield, August 11; Yellow Springs, August 12; Lagonda, August 16 (grasses).

Neurocolpus nubilis (Say). Springfield, August 11-25 (pokeberry, tall weeds).

Adelphocoris rapidus (Say). Springfield, June 18, 1916, July 18, August 11-25; Yellow Springs, August 12, 14; Lagonda, August 16; Trenton, September 6, 12 (goldenrod), 15, 16 (ragweed, alfalfa), 23, 26.

Stenotus binotatus (Fabr.) Springfield, June 18, 1916; Aug. 15.

Garganus fusiformis (Say). Yellow Springs, August 12; Springfield, August 11-25.

Paracalocoris scrupeus (Say) var. Springfield, June 18, 1916.

Poeciloscytus basalis Reut. Springfield, August 11-24, June 18, 1916; Yellow Springs, August 12; Lagonda, August 16; Columbus, June 1, 1916.

Horcias dislocatus (Say). Springfield, June 6, 18, 1916.

var. **coccineus** (Emm.) Springfield, June 18, 1916.

var. **marginalis** (Reut.) Springfield, June 18, 1916.

var. **goniphorus** (Say). Springfield, June 18, 1916, July 8. Both the red and the orange forms are found.

var. **affinis** (Reut.) Springfield, June 18, 1916.

var. **nigrita** Reut. Springfield, June 6, 18, 1916.

These varieties were found on tall grass in an open field, and on ragweeds. There are two other forms which do not belong to any described variety.

Poecilocapsus lineatus (Fabr.) Springfield, June 18, 1916, July 8, 14. Columbus, June 1, 1916. Both the green and the yellow forms were found.

Capsus ater (Linn.) Springfield, June 18, 1916.

Lygus pabulinus (Linn.) Springfield, August 15.

Lygus belfragei Reut. Springfield, August 23.

Lygus pratensis (Linn.) Springfield, June 18, 1916, August 11-25; Yellow Springs, August 12, 14; Lagonda, August 16; Columbus, June 1, 1916; Cincinnati, May 3; Trenton, September 6 (red clover, ragweed, thistle), 12 (goldenrod), 15, 16 (ragweed, alfalfa), 23, 26.

Lygus pratensis var. **oblineatus** (Say). Yellow Springs, August 12.

Lygus plagiatus Uhler. Springfield, August 11, 16; Trenton, September 26.

Lygus campestris (Linn.) Yellow Springs, August 12; Springfield, August 16, 23.

Lopidea confluenta (Say). Springfield, August 11, 15, 20 (locust).

Orthotylus flavisparsus (Sahlbg.) Springfield, August 24; Trenton, September 23.

Ilnacora stalii Reut. Springfield, August 11-25 (Artemisia); Trenton, September 6 (catnip),12, 15 (alfalfa),16 (ragweed).

Ilnacora malina (Uhler). Springfield, June 18, 1916.

Reuteroscopus ornatus (Reut.) Springfield, August 11-25; Yellow Springs, August 12; Lagonda, August 16; Trenton, September 6 (sweet clover), 15, 16 (ragweed).

Plagiognathus politus (Uhler). Springfield, August 24, 29; Trenton, August 6, 16, 23.

SECOND ALPHABETICAL LIST OF THE LICHENS COLLECTED IN SEVERAL COUNTIES OF NORTHERN OHIO.

Edo Claassen.

Since June 1912, when the first list was published in the Ohio Naturalist, 23 lichen species, not yet listed, have been collected. The name of the counties, where the collections were made, are again abbreviated as before: C stands for Cuyahoga, E for Erie, G for Geauga, L for Lake, O for Ottawa, S for Summit and St for Stark.

Several of these lichens, such as Arthopyrenia macrospora, Arthopyrenia quinqueseptata, Bilimbia trachona, Lecanora tartarea, Lecidea myriocarpoides and Lecidea pycnocarpa, seem to be quite rare. It is hoped and expected, that in coming years some more species can be added, mainly by excursions to localities not as easily accessible as those which usually have been visited, for instance the islands of Lake Erie.

List of Lichens:

Acarospora cervina fuscata (Schrad.) Fink. On sandstone: C.

Amphiloma lanuginosum, (Hoffm.) Nyl. On base of tree: C, on rock: C, L.

Arthopyrenia macrospora Fink. On bark (maple): C.

Arthopyrenia punctiformis fallax (Nyl.) Fink. On bark (poplar): C.

Arthopyrenia quinqueseptata (Nyl.) Fink. On bark (ash, maple): O.

Bacidia endoleuca (Nyl.) Kukx. On bark (sycamore): C.

Bacidia inundata (Fr.) Koerb. On sandstone: C.

Biatorella moriformis (Ach.) Th. Fr. On dry and rotten wood: C, St.

Bilimbia trachona Flot. On limestone: O, on sandstone: C.

Buellia myriocarpa (Lam. and D. C.) Mudd. On rotten wood: C.

Buellia spuria (Schaer.) Arn. On sandstone: C.

Cladonia delicata (Ach.) Floerke. On rotten wood: C, E, G, S.

Cladonia macilenta Hoffm. On rotten wood: C.

Lecanora dispersa (Pers.) Floerke. On old bark: E.

Lecanora subfusca campestris Schaer. On sandstone: C.

Lecanora tartarea (L.) Ach. On rock: G, L.

Lecidea contigua convextella (Wainio) Fink.   On granite
     boulder: C.
Lecidea lactea (Flot.) Schaer.   On sandstone: C.
Lecidea myriocarpoides Nyl.   On old wood: L.
Lecidea pycnocarpa Koerb.   On rock (conglomerate): G, L.
Placodium pyraceum (Ach.) Fink.   On old wood and sand-
     stone: C.
Rhizocarpon alboatrum (Hoffm.) Th. Fr.   On bark (maple): O.
Theloschistes polycarpus (Hoffm.) Tuck.   On bark: C.

OHIO ACADEMY OF SCIENCE

Annual Meeting

At a meeting of the Executive Committee, held in Columbus on December 8th, it was decided to hold the next Annual Meeting of the Academy in Columbus, May 30 and 31, 1918. The usual detailed notice will be issued later.

Saturday, June 1, will be available for field trips for such of the sections as may desire to hold them, the late date being unusually adapted to this purpose.

A more prominent place on the program will be given to the exhibition of specimens, microscopic preparations, drawings, models, scientific apparatus, etc., than at previous meetings. It is expected that definite hours will be assigned for such demonstrations, when the exhibitors will be present to give any desired explanations.

EDWARD L. RICE, *Secretary*.

THE

OHIO JOURNAL OF SCIENCE

TABLE OF CONTENTS

THE RELATION OF WAR TO CHEMISTRY IN AMERICA.*

By JAMES R. WITHROW.

War is an evil beyond the power of language to express. To kill one's neighbor or one's enemy is so repellant a thought that one cries out in horror at the idea and instinctively wants to refuse to have any part in action or government which involves such baseness irrespective of the provocation. It is only with the greatest difficulty that we persuade ourselves to act together in any such capacity except in spontaneous defense. Were it not for the religious emphasis upon our duty to support the civil magistrate in the execution of righteous law, and therefore to resist aggression against such law, we would find little ground to stand upon in our present crisis, except it be the desire to bring annihilation upon the philosophy which gave rise to this world war.

It has become more and more apparent that we have been dealing with a power in the case of Germany that is as unscrupulous as her acts are unmanly and cruel, and that the complaints of her opponents against her since 1870 have probably not been overdrawn. The pall of horror and indignation which fell upon us during the invasion of Belgium and France was

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*The annual address before the Ohio Academy of Science, Columbus Meeting, evening of April 6, 1917.

relieved when the Marne gave hope that there was still power enough in the world to frustrate the dream of the bully.   This pall has been slowly growing upon us again, however, in spite of the persistent efforts of the German propaganda amongst us to conceal and belie the reports of the damnable conduct of their armies and government at home and in the hapless countries for a time at their mercy.   Because of these things we see men everywhere bowed down and depressed as it becomes clearly demonstrated that science, mental endowments and education are no specifics against a wicked heart.   These things we really knew before but refused to believe.   They are demonstrated to us now by appalling examples so that the whole thinking community has become so mentally and spiritually depressed that one has great difficulty in going about one's normal work, health is damaged and continued research is a matter of great difficulty.   A nation of unusual opportunities, great mental endowment and development in science seems to have become the willing or at least easily manipulated pawn in the hands of the unscrupulous statesman.   We have not forgotten that it was a chemist Ostwald, in the early days of the war when he was acting as spokesman for Germany to men of science throughout the world, who was quoted, when Germany was in the flush of her initial victories over Belgium, as saying, the world had outgrown the idea of freedom for little or weak peoples.

War, therefore, is a universal mental depressant and as such alone, must damage progress in science.   It saps national energy and material resources.   It destroys the life of the younger generation of scientists and in large part, the student material from which the scientists of the future are recruited.   It interferes with systematic research in many lines by mentally depressing the workers, placing insuperable difficulties in their path and at times by destroying priceless work, records and literature.   Certainly war is not desirable to science, even if we could restrain our detestation of it and all its works.

Bitterly as we may condemn war, we would be wrong, however, to claim that science stagnated or declined in war time. Since war requires brains, science is of course utilized, and since the demand is inexorable, science must produce, and when science and engineering are producing, they grow.   We have come to learn that modern war is a scientific business under-

taking. It involves the use of all vital human endeavors, and therefore to varying extent, of all applied science. On the one hand, it involves the utilization of medical science to maintain physical efficiency and speedily repair damage to the fighting machine. On the other hand, it involves the utilization of agricultural, physical and chemical science in feeding and clothing the whole military and naval establishment, and manufacturing the equipment, armament, and "concentrated energy" or explosives consumed by the fighting force. It is stated that it requires three men in the shops to maintain one man in the army and seven men for one in the navy. It is evident, therefore that it is the applied portions of science that are most used and hence that grow most under war's influence. It is common experience, however, that the stretching into new domains and the striving for new goals by applied science enriches the feeding ground of unapplied science and uncovers fertile fields for the patient and quiet research which follows and which often becomes the very backbone of science itself. These results are scarcely visible and will not mature in any event, for years after the war, so that we can see at present little good effect upon unapplied science and we feel quite certain that the reverse influences have the upper hand.

Although it would not be wise at present even if we had the time to go into detail in discussing this subject, nor would it profit you particularly, yet it may be useful to emphasize certain points of view which come sharply to our attention when we attempt to survey the field.

WAR'S DAMAGE TO UNAPPLIED CHEMISTRY.

We could scarcely expect to estimate the retarding effect of the war on chemistry, because we cannot pry into it deeply and broadly enough to prove our impressions, for research is partly in the minds of scientific workers. However, certain signs of influences actually exist which tend to weaken and retard progress. The American Chemical Society of some 9,000 members, the largest chemical society in the world, publishes twice a month the journal "Chemical Abstracts. Its editorial offices are in the Chemistry Building, a few steps from the one in which we are now assembled. "Chemical Abstracts" has for some years covered the field of chemistry by abstracts more thoroughly than any foreign journal of the kind. It reviews

some 600 journals from all parts of the world and there is spent
upon it by the American Chemical Society an annual budget of
over $40,000.   It is easily seen that this must be the most pow-
erful and most important agency for research in chemistry, and
perhaps also in any science, that exists in the world.   Some
quantitative idea of the evil effect of the war upon chemistry in
general may be gotten from its effects upon this colossal agency
for assisting applied as well as unapplied research in chemistry.

Inquiry to the editor of "Chemical Abstracts" developed
that the effect of the war on current chemical literature as
reflected in "Chemical Abstracts" may be shown approximately
by the following statement:

"Total No. of abstracts published (patents included):
  In 1913—25,971   In 1915—18,449
  In 1914—24,388   In 1916—15,784"

These figures are fairly representative of actual publication
of original papers of more or less direct interest to chemists
as Chemical Abstracts has continued closely to approach
completeness in spite of war conditions.   The quality of the
papers being published is somewhat below the normal standard.
Not a great many foreign chemical journals have entirely
ceased publication since the war started, but all show more or
less marked decrease in the number of pages turned out.   Most
of the French and German journals are published much less
frequently than in normal times, two or more numbers being
grouped under one cover.   Apparently no important English,
Italian or Russian chemical journal has ceased publication
since the war started.   The following list includes the journals
concerning which we have uncertain information, but which
indicates that they have probably ceased publication due to the
war:

ENGLISH (one journal):
  Chemical World.

GERMAN (eight journals):
  Bohmische Bierb.   Technikum.
  Deut. med. Wochschr.   Zentr. Exp. Med.
  Leipziger Farber-Ztg.   Z. exp. Med.
  Silikat-Z.   Z. Hyg.

FRENCH (thirty-one journals):

Ann. Mines.
Arch. biol.
Arch. intern. pharmacodyn.
Arch. intern physiol.
Arch. med. exp.
Betterave.
Brass. malt.
Bull. sci. pharmacol.
Bull. soc. franc. min.
Bull. soc. geol. France.
Bull. soc. ind. Amiens.
Bull. soc. ind. min.
Bull. soc. ind. Mulhouse.
LeCuir.
L'Engrais.
J. d'agr. trop.

J. des. fabr. sucre.
J. physique.
J. sci. math. phys. nat.
Radium.
Mon. ceram. verr.
Mon. teint.
Nord Brass.
Papier.
Petit brasseur.
Rev. chim. appl.
Rev. chim. ind.
Rev. electrochim.
Rev. viticulture.
Rev. gen. mat. color.
Sucrerie Ind. colon.

AUSTRIAN (one journal):

Oester. Z. Berg. Huttenw.

BELGIAN (seven journals):

Bull. acad. roy. med belg.
Bull. sci. acad. roy. belg.
Bull. soc. chim. belg.
J. pharm. soc. d'anvers.

Rev. intern. pharm.
Sucrerie Belg.
Chimiste.

The cost of publication of Chemical Abstracts has been increased by about 10% as a result of the war. This is chiefly due to the increased cost of paper. The same percentage increase will enter into the cost of the Decennial Index to Chemical Abstracts, which is about to be issued by the American Chemical Society at a cost of over $30,000.

Need we go further for evidence of the ill effects of war upon science? Certainly it takes little insight to see that this stoppage or at least side-tracking of the wheels of chemical research will be felt in this science for years to come.

WAR'S RELATION TO APPLIED CHEMISTRY.

In considering the applied side of chemistry let us remember that war is essentially engineering. Its object is to overcome natural and artificial obstacles. It must therefore get results which are deliberately selected at the will of those directing the war. It insists, therefore, that everyone and everything must produce. Its main agents are engineering and applied chemistry, the engineering, because it struggles with the problems of space

and time and material for tools and weapons, and applied chemistry, because it is a necessary handmaiden to efficient engineering, and in addition furnishes the source and vehicle for convenient and effective handling of energy in the most concentrated forms. The chemical energy of the modern high explosive is the strong right arm of the fighting force and without it, armies are but chaff. With British control of the seas, German armies with all their numbers, thorough equipment and splendid miltary power, would have been impotent in a few weeks or months without the chemical ability to get nitric acid from atmospheric nitrogen instead of Chilean nitrate, for without nitric acid high explosives and even smokeless powder are impossible.

The time at our disposal is too brief to touch on all the divisions of applied chemistry. Much progress, for instance, has been made in the domain of the special branch called engineering chemistry, which involves among other things, the chemical investigation of materials for alloys, shrapnel, aeroplanes, submarines and other war supplies. It would be unwise now that we have become involved in the war, to deal publicly with some of the improvements in this field, for they are vital as well as interesting. Some of us have followed the policy during the last three years of not even discussing with our colleagues or students such innovations of military importance in this and the allied countries as have come to our attention, which might by any means percolate into Germany. The branch of applied chemistry known as metallurgy, in which this country is perhaps the most highly developed in the world, also renders distinct service in war time because it is vital to engineering and in the production of arms and ammunition.

We, however, will emphasize more particularly the twin fields of industrial chemistry and chemical engineering, because in the nature of things this field is less popularly known even among chemists. Industrial Chemistry is that branch of chemistry which uses all the rest of chemistry and much engineering, for the furtherance of production of chemical substances, or, the use of chemical means or methods for manufacturing any material of commerce. Chemical engineering is that branch of engineering and industrial chemistry which applies engineering principles and methods to chemical man-

ufacturing or production. Because their aim is production, these two fields have been largely dominated by war conditions for the past three years. On them the war has had two mutually antagonistic effects, the one retarding or injuring and the other developing and benefitting.

WAR'S DAMAGE TO CHEMICAL INDUSTRY.

The main factors vital to success in any chemical industry are:

1. Thorough knowledge of an assured market.
2. Possession of at least one well studied and workable chemical process and chemical ability to handle it economically under varying raw material and finished product markets.
3. Possession of engineering ability to carry out and maintain in operation the chemistry involved in the process.
4. Sufficient margin of profit to attract capital and business confidence in chemical and engineering ability in meeting the problems of the field.

Anything or anyone who weakens or strikes at any of these four factors is an enemy of chemical industry and does damage to it.

When war was declared in Europe stagnation set in at once in the chemical industries and indications of disaster were the rule in many of them. Petroleum refining, turpentine, rosin and wood products among others were hard hit because we are strong exporters and such industries as mixed fertilizer manufacture also, because we import heavily of potash. This stagnation could not last long, since the chemical industries underlie the whole fabric of modern industrial development and civilization, and production is necessary to life. Eventually, therefore, the chemical industries were forced to resume operations but great uncertainty as to markets rendered operations difficult and held back many changes in processes and equipment, rendered necessary by changes in source or kind of raw materials. The nature of these industries is often such that the failure of supply of one chemical raw material even if used in but limited amounts may prove fatal by rendering the product unsatisfactory to the market if indeed it is not entirely valueless. A good illustration of the vital importance of accurate knowledge of the market in these chemical industries is furnished by the dye situation, where we had recently the

anomalous condition of bitter complaint of shortage by con-
sumers simultaneously with utter inability of some producers
to market their product, and still other producers with large
contracts for product and inability to produce due to poor
deliveries or failure of equipment. These difficulties do much
harm, since they tend to discourage capital and it must not be
forgotten that industrial chemical development is impossible
without capital. German chemical manufacturers understood
this clearly when they organized American branches of their
color works, eliminating American employees to conceal the
market and its peculiarities, and placing all their business in
the hands of "American citizens" of German name. Then
when the U. S. Bureau of Foreign and Domestic Commerce
attempted last September to publish the amounts of each
dye consumed in this country, they vigorously protested that
their rights as American citizens were being infringed by
encouraging competition. The uncovering of this octopus to
public gaze should be set down to the war's credit. It has
long been a familiar animal to many industrial chemists.

Another evil effect of war, a common one now greatly
intensified, is the discouragement of capital by failure of hasty
and ill-advised manufacturing projects. Successful specu-
lators and others have been influenced by the potential earning
capacity of industrial chemistry and have jumped into projects
with little study and no experience. Often such capital has
not known enough to employ chemical engineers, but has put
growing works into the hands of electrical and mechanical
engineers whose general engineering sense has not always saved
them from physical disasters that chemical experience would
have avoided. Such engineers and capital and sad to say,
many chemists, who either, lacking entirely in manufacturing
experience or having had manufacturing experience, though
they acquired no sense of responsibility to protect capital
against hazard from decisions without basis in experience,
have been the easy victims of the machinery and equipment
company who needs but to see a plant, or a picture in a book,
and they will design you one while you wait. There not being
the proper engineering check, such plants fail at times with
regretable loss of life as well as capital and confidence in things
chemical, or if they succeed (because the process is simple and
well known) the plant can be counted upon to cost from 50
to 100 or more per cent. higher than it should.

The equipment companies and their engineers are not necessarily dishonest. They sell equipment, and who but they are responsible if they do not sell you enough equipment when you consult them for advice in designing your plant? They, therefore, sell you enough. Experienced engineers will often cut the estimates of such equipment manufacturers in half.

Another illustration of how this situation works out in practice might be given in the case of benzol refining. This is an important matter in modern high explosive manufacture. Some little time ago the best text ever written in English on Industrial Chemistry contained a chapter by a chemical engineer who had ample opportunity of observing the best American practice (which happens to be second to none in the world). His chapter on this subject, therefore, is a classic, but in illustrating the text he did not reproduce details of stills, for instance, with engineering exactness but allowed the artist who made the drawings considerable leeway to his imagination. In fact, he left out entirely a vital feature in the construction of such stills. Were it not for the loss of efficiency and the expense involved, you would be greatly amused if you could go with me to a number of the refineries built in this country in the last two years under war pressure by machinery companies, for good engineers who were not themselves experienced in this industry, but who needed the industry as one of the links in their larger operations. In every case the stills were built exactly patterned after the picture in this text and in no case were they efficient or as nearly efficient as was possible, if a little thought regarding the use to which they would be put had been given them. They were built to sell, not to operate.

The same capital, newly invested in chemistry, is also the easy victim of another evil which is necessarily costly to industrial chemistry and is a heavy blow to the whole science. This evil is the ignorant or unscrupulous chemist. The great difference between industrial chemical research and other chemical research is that the former must produce results on the problem in hand while the latter may ramble if necessary into less difficult fields. When inexperienced capital is seeking chemical assistance the first individual it meets who claims to be a chemist is assumed to be competent to handle any problem without inquiry into his past experience. This same capital

would scarcely employ a bridge engineer to design a dynamo, yet plant after plant for chemical manufacture has been constructed in the last two years in this country with no more intelligence than this. As a result literally millions have been squandered and lost in these unsuccessful plants. But unfortunately, enough such plants are successful, that their authors escape the penalty of their dishonesty, and therefore, the evil persists and continues. Plants have been constructed for the manufacture of high explosives by engineers who knew nothing of the business, resulting in great loss of property and even life from their final destruction, or in abandonment where they proved unprofitable. I have heard of plants erected for the concentration of sulfuric acid in which a battery of stills for this purpose costing in the neighborhood of a quarter of a million dollars was placed in operation without even a single experiment preliminary to erection, on the type of material to be used, and not even a trial run on one of the stills before all were placed in operation. The first day they operated was the last day, for they all went into solution in the acid.

Men who were or claimed to be chemists have read how simply some reactions described in the general chemistries work, and designed a plant upon their nerve or—as they thought—common sense, and found to their consternation that under the conditions they made for themselves the reaction did not proceed at all, or they were so inexperienced in large scale operations that they could not recognize what they had when the work was under way. Others have so far lost their heads by publicity or financial possibilities, even though good chemists, that they have assumed that what could be done with raw material from one source could be equally well done with it when from another source, provided they merely proved its actual presence in the new product. Ignoring the whole history of chemical as well as industrial chemical development that the chemical environment profoundly affects chemical reaction, no adequate confirmatory studies were made before capital to the extent of hundreds of thousands of dollars has been induced to invest in such guesses, with disastrous results to capital and grave loss of confidence in chemical research. These things are in large part due to or at least the losses could only be so heavy under war pressure. Processes which gave every promise of success have been hurried into failure or near

failure by undue publicity giving premature capitalistic confidence in them and it is with profound regret that we see the passing for the time at least of such things as toluol from petroleum, which more attention to study may still make useful in war emergency at least.

These are outlines of some of the evil influences due to or accentuated by war. They are in part of such a technical or professional nature that they should not be imposed upon your attention unless it were to protect you against misunderstanding the just criticism of the results of these evils and to emphasize that we do not consider war an unmitigated blessing if we should appear enthusiastic about the progress that has been made in war time. Then too, we should always ponder more over our lapses. The successes can take care of themselves.

PROGRESS IN APPLIED CHEMISTRY IN WAR TIME.

There is indeed another side than the evil we have been discussing. There has been much real progress. The evils mentioned are largely growing pains. Engineering and its services to mankind have been long appreciated to some extent at least. Chemistry is less easily understood. The everywhere present applications of chemistry pass unnoticed for the most part in everyday life. Probably the greatest contribution to science, therefore, of the present war, is the awakening of the average mind to the power and value to mankind of that group of phenomena which we study as chemistry. This is probably because we most easily grasp and appreciate applications rather than generalizations, and the use of chemistry in war has been a revelation to the general public.

In other ways also this war has affected a development in chemistry and its applications which has outstripped any influence since the modern foundations of the science were laid over a century ago. It will be many years before the influence will mature and become apparent or measurable. Nevertheless, we do not crave progress or development at such a price as war.

We must recognize, however, that severe disturbances are very effective in dislocating fetishes, for instance. So, one of the phases of this struggle which is noteworthy is the public awakening to consciousness of the power of chemistry and the

universal distribution of the ability to use it promptly and effectively, as against the old idea, that this power and this ability is possessed by a chosen few.   An illustration or two will perhaps show that this latter idea is still too prevalent.

I have met manufacturers since the war whose operations were brought to a full stop by lack of some raw material or other who complacently accepted their fate on the ground that they could not get a German chemist.   They had no bias in favor of Germany at all.   They just thought it was a matter of common information that chemists were domestic animals imported from the Black Forest.   Would you believe that some of these manufacturers were engineers graduated from some of our large colleges of engineering and not men without education?

In such a time as this we see that our keeping quiet about the progress and development of American chemistry in years gone by, was criminal, for much harm results from lack of information as well as from misinformation.   There are always patriotic Germans and others who praise their country's achievements to us and as I pointed out last year in your OHIO JOURNAL OF SCIENCE, we are glad to see this and our University teachers of chemistry have been lavish in their praise, particularly of German chemistry.   They, however, are not rendering very good service to the community when, as they should, they give such praise if they fail to make a real effort to find out also what is going on in their own country.   We university professors feel abused if it is inferred that we are not well informed, yet we innocently assume as the only modern development in chemistry the latest tale of achievement from a German dye advertisement and these lads know how to use the educated public and university chemistry professors as well, in furthering their advertising propaganda.   Much good work has been done by the "Journal of Industrial and Engineering Chemistry" in publishing a series of articles by authorities, on what the American Chemist has done for the individual industries. Time only will eradicate the evil.   Only a short time ago I was at a banquet of a society of engineers in an eastern city.   The professor of chemistry from a nearby university was an invited speaker.   He was a revered and respected man among American chemists and a man of affairs, too, but he lived in the dark ages of chemical achievement.   He spent half of his time telling how wonderful chemistry was and how great the achievements of

foreign chemistry in particular, and not one word of American chemistry. Yet in his own city in the last three years has sprung up a chemical industry that is marvelous, and which he did not know existed. In his own line, organic chemistry, was a plant for making certain organic materials used in war by a series of steps that has no counterpart in chemical literature for the magnitude and conception of its chemical engineering operations. It is not only the largest scale upon which all of its many operations have ever been conducted but its chemistry is a series of highly interesting adaptations and developments. When peace comes again, if that plant still prospers it will be a useful aid in the solution of one of our most important engineering problems of this generation. Americans are not wizards that they do in two years what it took German chemists decades to work into. Such things are only done where the ability exists and the power born of experience in solving similar chemical problems, is possessed. It is not right to our students, you who teach, to praise the competitors of our compatriots and never stir yourselves to be informed on what our own countrymen are doing, even if, the foreign achievements are served up to us, ready to teach as paid advertisement of German dye-makers. The German general staff has learned, if others have not, that German chemical achievement which is great indeed, is no sign that equal ability does not exist elsewhere. The Allies and America improvised a munitions industry in two years to match their machine of forty years preparation. Such an achievement is only the natural result of our present industrial chemical development in America and the Allied countries. There is nothing in the rate of American industrial chemical development of which any American need be ashamed.

The progress in industrial chemistry and chemical engineering in the last three years itself, in this country, has been wonderful. Let me protest, however, that this is no ground for the philosophy which I understand obtains in some quarters, that war is a desirable, natural, logical or sort of evolutionary benefit. All this progress is in spite of war. War could force us to do nothing we did not possess capacity for before. Because war changes the normal relations between supply and demand, cost and selling price, gives us opportunities to do only what we could do anyway, if the same demand arose from any other cause.

Industrial chemical tendencies during the war have been governed by unusual demands for chemicals from abroad in addition to war drains, healthy home requirements, new demands from industries formerly supplied from abroad or forced to use new raw material by scarcity or high prices, together with speculation, raising prices to unusual levels. This resulted in expansion of existing plants, rapid installation of new ones, hasty perfecting of new processes already slowly maturing and the seizing of opportunities to profit by high prices through erection of small plants for the production of special chemical materials and through the development of processes hitherto existing as possibilities, only, in the minds of chemists. This has greatly extended also the supplying of chemical construction materials and machinery and has increased the opportunities for the rapid development of inventions in this line. The progress made here alone has been as great as has been accomplished in many individual decades in the past. The importance of this is apparent when we consider that if the chemical engineer had at his disposal as efficient apparatus and materials of construction in his plant, as exist in the chemical laboratories of the present day, or as the mechanical and electrical engineers have in their work, progress in the arts would be at least a hundred years ahead of its present development.

The tendency to manufacture at the market is another good development which has been greatly accentuated by the war. For some time there has been a growing tendency for manufacturers who are large consumers of chemicals to produce these chemicals themselves. Assisted by gradual price elevation, this tendency has been greatly encouraged by the invention in the last two decades of processes and machines of merit which could find no sale as such, in well established chemical manufacturing plants, because they frequently offered insufficient advantages to warrant discarding those already operating, or were merely alternative in their character. A good example of how this tendency to manufacture at the market, works out normally where the impelling force is merely gradually advancing prices, competition preventing excessive elevation, is to be seen among others, in the case of bleach for paper manufacturing. Consumers of alkali and bleach, such as progressive paper manufacturers, operating on a large scale, and others have

experimented for years with inventions for the electrolytic production of these materials from common salt. Our present high development in this branch of chemical industry is in no small degree due to these individual efforts, many of which during the past twenty years have been eminently successful. High prices and poor deliveries in the last two years have forced matters to a head in this direction. Where formerly we had a few large chemical plants manufacturing caustic soda and chlorine for bleach by electro-chemical means, we now have distributed throughout the country a great number of concerns who have added to their equipment a plant for the production of these products. The operation of these units under widely diverse conditions will greatly enrich our chemical engineering experience. A number of cell types are obtainable which operate economically. Some of these are well advertised in the current literature, but some though equally successful, such as the Allen-Moore, Gibbs, and Nelson Cells, are not so well known. The cell portion of such a plant is only a fraction, however, of the equipment required and it is important that the rest of the plant should be properly designed. The simpler and more durable, therefore, the design of apparatus, the more satisfactory the entire equipment will be. There has been placed in operation in some eight plants recently a total of nearly 2,000 cells of one type alone, with a daily capacity of 200,000 pounds of chlorine gas. Some plants constructed this year cost as much as a half million dollars. These will be valuable for defense, for we use much chlorine in making guncotton or nitro cellulose for mines and smokeless powder.

This use of alternative inventions is valuable in encouraging new invention and much industrial chemical investigation, and alleviates to some extent the ill effects of unwarranted increase in selling prices.

Progress in Chemical Engineering may be illustrated perhaps best by the progress in acid making equipment. High pressure manufacturing of chemicals and difficulty of obtaining supplies has brought rapid improvements and development of chemical engineering materials by compelling large scale experimentation of new products and substitutes. To resist corrosion by acid and other chemicals, pottery or so-called chemical stoneware, glass and natural stone apparatus have been used heretofore.

This necessitated small sized apparatus, and meant in the case of stoneware a manufacturing time of about two months for the clay working, drying and cooling after firing. Attempts have been made for many years to replace this material by metal. Platinum, silver and gold are used in special cases, but while these metals can be made into any size apparatus, cost is prohibitive for most uses. Two classes of alloys have now been developed: rare metal alloys, such as tungsten, chromium, or nickel irons, and more recently the cheaper and more resistant silicon-iron alloys. Extensive trials in the last two years have shown the usefulness of these alloys though they do not possess quite the resistance of stoneware to corrosion. They are known under varying trade names, such as durion, made here in Ohio, tantiron, and ironac. They are very resistant to all strengths of sulfuric and nitric acids and are used with great satisfaction in their manufacture and permit plants to run for months without shut down. The success of the modern tower system displacing platinum for concentrating sulfuric acid has been largely due to the use of pipes and fittings of this alloy.

Early in 1915 the demand for nitric acid for war purposes increased to enormous proportions resulting in extensions to old nitric acid plants and the erection of new ones larger than the world had ever seen. Deliveries on stoneware jumped to six months and even longer and had the production of nitric acid been dependent upon stoneware alone, as a few years ago, it would have been greatly curtailed and the story of the great war would have been different. As these alloys can be secured on short notice, the same as cast iron, chemical manufacturers do not hesitate if a still should run wild and froth sodium sulfate into the condenser to direct workmen to break the connections at once with a hammer and allow the expelled material to flow on the floor, thus preventing the wrecking of the condensing apparatus. New castings can replace the broken one at once. Such extravagant handling of the material would not be possible under the usual slow deliveries with stoneware. This freedom from risk of damage to condensers and the making of condensers themselves of this material, enables stills to carry a heavier charge and be operated at greater speed. Where the old equipment charged 2000 lbs. once or twice in twenty-four hours, these war-time stills operate on 6000 lbs. of nitre, plus 4000 lbs. of sulphuric acid, charging

three times per twenty-four hours. The alloy is somewhat brittle, but very much less so than chemical stoneware. It is easy to see these silicon-iron alloys are a boon to the acid industries and thousands of tons of castings are in use and new chemical processes are possible and now in operation, too, which could not exist before, because of lack of suitable material of which to construct apparatus. Some of these new processes are having a decided value in the Allies' campaigns. No single development in many decades has had as much influence as this one has, and will have, for it is only in its infancy.

I need not weary you with other illustrations of progress though much has been accomplished in many lines and radically new chemical processes developed. The most wonderful and greatest chemical works I have ever seen have been erected in this country since the war began and the best of them were coal-tar dye and synthetic organic chemical works. Reasonable progress has been made in American laboratory glass and porcelain. After the war we are going to be independent of importation in gross coal-tar products and practically if not entirely, in ammonia for fertilizers. We are also weeding out the unnecessary use of potash where it replaces soda due to our own careless teaching of chemistry in speaking of and using potassium compounds where sodium serves as well. German potash exporters and others, such as for Saxony manganese, after the war will have an expensive campaign to win us back to these former unwarranted uses of their product.

The relation of chemistry to national defense has been rendered clear by the war, a service of no mean magnitude.

Explosives and asphyxiating gas manufacture are dependent upon labyrinthian chemical engineering operations. It is obviously necessary for adequate preparedness that this country should be self-contained and not dependent upon importation for such supplies as nitric acid, toluol and sulfuric acid for defense. We have the sulfur and pyrites for sulfuric acid. The toluol and other coal-tar products we have ample for our usual needs, but in time of war toluol becomes the basis of "T. N. T." or trinitrotoluol, one of the most effective high power military explosives. The erection of new coke oven plants has but partially met the demand for toluol in the last two years. In defending ourselves this would be too slow, for such installations are difficult to get under successful opera-

tion in less than a year.   A large and well established dye
industry, therefore, is vital for defense, for it would produce a
bigger demand for coal tar products and toluol production in
peace times and its operations are quickly convertible into
ones for producing high explosives.   It is to be hoped therefore
that the German alliance with our textile manufacturers may
be broken up during this war so that Congress will be less
helpless in fostering this dye industry as a matter of defense
than it has been in the past.   The expense of storing within
the country nitrate of soda imported from Chile, adequate
for the nitric acid of munitions production in case of war,
would tie up millions.   The Government will establish a
plant to make nitric acid from the atmosphere.   The Norwegian
process (electric arc) is stated to require five times as much
power, a vital factor, as is required in the making of nitric
acid from cyanamide.   Germany has installed for making
cyanamide, during the war additional equipment costing
$100,000,000, utilizing over 600,000 horse power and producing
about 200,000 tons per year of nitric acid, requiring the most
feverish activity for a year and a half on the part of her chemical
engineers.   We have some American suggestions which if
successful will take less power than the German method.   Any
method for nitric acid producing ammonia also, is desirable as
an aid to agriculture.   Prices asked for power are much higher
than abroad and as the cost of engineering is only about 10% of
the total charges in electric power installation, it becomes
evident that efficient national defense and economic agriculture
depend on more economic banking methods.   So in every
instance we are confronted with the problems of peace when
working out national defense.   It should be remembered that
our usual source of nitrogen derivatives, the ammonia of by-
product coke, brings with it the indispensable toluol, and no
electrical method does this.   Before the Government nitrogen
plant is built, therefore, it should be a matter of serious inquiry
whether the Government's $20,000,000 might not bring the
same result and give a liberal supply of toluol besides, if invested
in by-product coke expansion, for much of our coke is still made
without saving by-products.

   It is an open secret that the acceptance of war orders in
this country strained to the breaking point our best organized
chemical industries.   The mere request by the allied countries

two years ago for our soda, benzol, toluol and our explosives for only a *small portion* of their demands, produced a state of affairs in our industries that was an appalling warning against the time when we would need such things ourselves, for defense, and in immensely greater volume.

It is natural in view of the nature of these defense problems that the engineers and chemists of the country have been serious in the preparedness movement. Thirty thousand engineers and chemists of the United States volunteered without pay to the National Consulting Board for both the Navy and Army to work on the organization of the industries of the country for national defense. The result was much more efficient than any similar organization in the world, for no government could afford to pay for the expert services involved. This Consulting Board and its successor, the National Council for Defense, have assisted the country to become self-contained for defense, arranged for speedy conversion of industrial plants into munitions plants and arranged during peace to prevent useless waste of experienced engineers. Experienced chemical engineers for instance, like naval officers, cannot be trained in a day or a year, though the analytical chemical control can be taught in a few days to any chemist. The mistakes made by Britain in passing through the blockade materials helpful in explosive manufacture demands that our military authority and foreign office have at its call as wide a variety of chemical experience and advice as possible, and every chemist as well as engineer in this country is now being card indexed.

If we as scientists ask ourselves individually what we can do to assist in the general defense of our firesides and our ideals, the answer is do our daily work in whatever field it may be, as though it were the most important single thing in the world and *particularly do our utmost to assist production and those directly engaged in it, whether manufacturing or agricultural.* Then when the government calls upon us for special service we will be ready to attack the problems which only the military arm can formulate for us.

We have touched on sufficient high points to indicate the character of the influence of the war upon chemistry in America. Still other points should be discussed, were there time. Hardly any branch of the science but contributes an important service to the national defense as well as our normal benefit.

After all is not chemistry and science itself a petty matter in the presence of this world calamity and the personal suffering ever upon our minds?   Have we not often wondered what we had done to be spared to this minute from such things?   It may be proper to say we do not quarrel with the German people as such, but with the ideals and acts of their leaders and government.   Do not let that point of view toward our neighbor, however, be used by us to excuse our individual responsibility for this government and its every act.   We are responsible, and we alone.   We have seen conclusive proof in the last three years that science and education are merely aids and not specifics against international immorality and that the devotees of science are as easily misled as others when the leaders too are scientific.   Though this war has long become evident as a war for privilege and the exploitation of the weak by the strong, and the doctrine that the state *can* do no wrong rather than that the state *must* do no wrong, let us not deceive ourselves that our abolition of aristocratic government is a specific for this malady, for it is not.   This is our constant battle still, even under our form of government.

It has become so evident in this war that the intelligent and scientific criminal is a terrible menace, and dislodging him at times such a weary and fatal task, that we must find some way of preventing our leaders and groups or classes, whether governmental or industrial, from becoming this kind of danger.

Have we not reached the time when we are willing to turn to the One who ordained civil government for our good, acknowledge that He ordained it and not we ourselves, and make our leaders or rulers "Whom God and this people shall choose"— "men fearing God and hating covetousness?"

The Ohio State University, Columbus.

NEW LIGHT ON THE STATUS OF EMPIDONAX TRAILLII (AUDUBON).

By Harry C. Oberholser.

Few birds are so puzzling as the flycatchers of the American genus *Empidonax*. None of these are more difficult to understand than *Empidonax traillii* and its closely related forms, the status of which has long been in dispute. The careful investigations and reasonable conclusions of Mr. William Brewster,* have long been accepted as the final word by ornithologists generally; and it is with some degree of reluctance that the writer now reopens the case. Subsequent identification of breeding specimens, however, from the north central part of the United States, from Ohio to Arkansas, Missouri, and Iowa, has indicated discrepancies in the range of *Empidonax traillii traillii* as currently delineated. With the idea, therefore, of confirming Mr. Brewster's conclusions and settling the identification of specimens of this species in the Biological Survey collection, the writer resolved to investigate the matter *de novo;* and to this end has examined a large amount of material; in all, 411 specimens. The rather surprising and, to some extent, unfortunate results of this study were announced at the meeting of the American Ornithologists' Union at Philadelphia in 1911, and therefore they long ago should have been placed on permanent record.

For the preparation of this paper the writer has made use chiefly of the collection of the United States National Museum, including that of the Biological Survey. In addition, he is indebted for the loan of specimens and for other assistance to Mr. P. A. Taverner, Mr. F. C. Lincoln, Mr. L. J. Hersey, and Mr. F. Kermode.

EMPIDONAX TRAILLII TRAILLII (Audubon).

Muscicapa traillii Audubon, Birds Amer., folio ed, I, 1828, pl. 45 (woods along the prairie lands of the Arkansas River, Arkansas).

Empidonax traillii alnorum Brewster, Auk, XII, No. 2, April, 1895, p. 161 (Upton, Maine).

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*Auk, XII, No. 2, April, 1895, pp. 159–163.

Chars. subsp.—Bill rather small; upper surface decidedly greenish; wing-bars whitish, tinged with greenish or yellowish.

Measurements.—Male:† Wing, 64.5-78 (average, 71.7) mm.; tail, 54–62.5 (58.2); exposed culmen, 11–13 (12); tarsus, 15.5–17.5 (16.7); middle toe without claw, 9–10.5 (9.5).

Female:‡ Wing, 64.5–75.5 (average, 68.3) mm.; tail, 51.5–61.5 (55.2); exposed culmen, 10–12.5 (11.6); tarsus, 14.5–17.5 (16); middle toe without claw, 8.5–10 (9.4).

Type locality.—Borders of the woods along the prairie lands of the Arkansas River, Arkansas.

Geographic distribution.—North America, except the extreme northern part, south to Central America and northwestern South America; no authentic record for the West Indies. Breeds in the Hudsonian, Canadian, Transition, Upper Austral, and occasionally the Lower Austral zones in North America, north to Newfoundland, central Quebec, northern Ontario, northern Manitoba, northwestern Mackenzie, and central Alaska; west to western and southeastern Alaska and western British Columbia; south to central southern British Columbia, northwestern Montana, southeastern Montana, southern South Dakota, northeastern Colorado, central Arkansas, southern Kentucky, southern West Virginia, western Maryland, Pennsylvania, and northern New Jersey; east to eastern Massachusetts, eastern New Hampshire, eastern Maine, Nova Scotia, and Newfoundland. Winters south to Ecuador; and north to northern Colombia, Costa Rica, Nicaragua, and Yucatan, Mexico. Migrates west to central Colorado, western Texas, and Oaxaca.

Remarks.—The best characters to distinguish the eastern form of this species from that of the western United States, from Colorado to California, are the more greenish upper surface, the more greenish or yellowish wing-bars, and smaller bill. Every specimen does not exhibit all these characters to the best advantage, but enough are usually present to render possible satisfactory identification. Furthermore, the eastern bird is somewhat darker above, though this is not more than an average character.

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†Thirty-seven specimens, from New England, Illinois, Minnesota, North Dakota, and Montana.

‡Twenty-eight specimens, from New England, Pennsylvania, New Jersey, District of Columbia, Indiana, Illinois, North Dakota, Yukon, and Alaska.

The geographic variation in this subspecies is not great. Breeding birds from Maine and New Brunswick seem to be absolutely indistinguishable from those taken at the same time of year in Maryland and in Mackenzie, Canada. Furthermore, birds that breed at Fort Keogh, Montana, appear to be prefectly typical. Birds from North Dakota, South Dakota, Nebraska, northeastern Colorado, and extreme western Montana are intermediate, in that there is among them more individual variation, rendering some individuals difficult to distinguish from the bird of the far western United States. They are, however, as a whole, decidedly nearer the eastern race. Likewise, breeding birds from Ohio, Indiana, Illinois, Arkansas, Missouri, and Iowa, as well as from Michigan and Wisconsin, must be referred to the New England race. This, therefore, obliterates the zonal distinction between the breeding ranges of the two forms of this species, which Mr. Brewster* has delineated.

One of the things brought out by the present study is the great and very complicated individual color variation that exists in both geographic races, which greatly increases the difficulty of identifying individual specimens. The wing-bars in the eastern bird are usually whitish, more or less tinged with yellow or greenish, but occasionally these are decidedly brownish, much resembling those of the western form of the species. The lower parts are sometimes as yellowish below as in *Empidonax virescens*, but are usually more grayish or whitish. Furthermore, the upper parts exhibit at least six more or less well marked color phases, which, by individual variation, merge imperceptibly into each other, so that there exists an infinite variety of coloration. These phases, if such they may be called, fall naturally into two series, separated in a general way by the pattern of the upper surface. In one the color is almost uniform from forehead to upper tail-coverts, and the type of *Muscicapa traillii* Audubon is a bird of this kind; in the other style the pileum and cervix are, in color, conspicuously different from the back, being either more brownish or grayish and forming a rather well defined cap. Birds of each one of these styles exhibit three color phases: (1) dark greenish, which is apparently the normal coloration, in which the upper parts are

*Auk, XII, No. 2, April, 1895, p. 159.

decidedly greenish with no yellowish tinge; (2) yellowish green, which is very much less commonly observed, a condition in which the greenish of the upper surface is decidedly tinged with yellowish, particularly on the interscapulum; and (3) a grayish phase, in which the olive upper surface is decidedly grayish with no yellowish and but little greenish tinge. So different are some specimens of these six phases that they look like different species. One specimen, an adult from Fort Simpson, Mackenzie, taken in July, 1861, is so brown that in color it actually is not with certainty distinguishable from California birds of this species; in fact, were it from a breeding locality anywhere within the range of the Great Basin bird, one would unhesitatingly refer it to that form. It is an example of the difficulty which attends identification of some of the individuals of this flycatcher, and shows that single individuals occur which are practically impossible to assign subspecifically without assistance from some other source than the color of the plumage.

Seasonal variation further complicates the case. By the wear of the plumage some adults become, by July, very much paler and more brownish above, as well as somewhat so on the lower parts; in which condition examples of the eastern and northern race (*Empidonax traillii traillii*) are easily mistaken for the form of the western United States, hereinafter described as *Empidonax traillii brewsteri*.* A bird taken on June 25, 1894, at Canton, Illinois, is in this condition, and is practically indistinguishable from worn specimens of the western race. This specimen was doubtless partly responsible for Mr. Brewster's reference of the Illinois birds to the western sub-species. Since, however, breeding birds from all the surrounding region now prove to belong to the eastern race, *Empidonax traillii traillii*, this example is certainly but a worn, abnormally brown individual of the same form.

Birds in juvenal plumage are also sometimes difficult to decide subspecifically, because those of the eastern race are, on the upper parts, much more brownish than the adults, and thus often readily, at least superficially, to be mistaken for western representatives.

Mr. Brewster's transferrence of the name *Empidonax traillii traillii* to the western subspecies was made on the

* Postea, p. 12.

identification of the type specimen, now, as then, preserved in
the United States National Museum.   Mr. Brewster mentions *
three specimens in the United States National Museum marked
as types of *Muscicapa traillii* Audubon; viz., Nos. 960, 1865, and
2039.   The first of these, No. 960, is now not to be found in
the collection, but it was entered as *Tyrannula minima* [*Empi-
donax minimus*] in Baird's own handwriting in the original
catalogue of his collection, which formed the beginning of the
National Museum bird register.   Without much doubt, there-
fore, "No. 960" in Mr. Brewster's article is a typographical
error for No. 2960, which is still in the National Museum col-
lection, and is one of the two birds still marked with a red type
label.   Of these two supposed types of *Muscicapa traillii*
Audubon, one is No. 1865, U. S. Nat. Mus., likewise the same
number of the original Baird collection; and it is also one of the
three specimens mentioned by Mr. Brewster.   This bird,
together with another, numbered 1866, were entered by Pro-
fessor Baird in his catalogue in January, 1845.   On the label
of No. 1865 there is the following inscription in Baird's own
handwriting, the "(X)" indicating that the specimen was
received from Audubon:

| *Tyrannula trailli* Aud. |
| 1865   (X) |

This specimen, considered alone, is without any doubt
referable to the eastern race, and it agrees absolutely with a
specimen, No. 165385, U. S. Nat. Mus., from Mountain Lake
Park, Maryland, collected, July 3, 1899, by E. A. Preble; the
only observable difference, and this slight, being its rather more
yellowish posterior lower parts, very slightly duller wing-bars,
and partly darker, somewhat more greenish upper surface.
It is in somewhat worn breeding plumage, but it is about as
near a match for this Maryland bird as is any bird in our series.
It measures as follows: wing, 73.5 mm.; tail, 58; exposed
culmen, 11.2; tarsus, 18; middle toe without claw, 9.   The
original locality of Audubon's *Muscicapa traillii*, as given by
him,† is the "Skirts of the woods along the prairie lands of the
Arkansas river."   Mr. A. H. Howell has recently collected

*Auk, XII, No. 2, April, 1895, p. 160.
†Ornith. Biog., I, 1831, p. 236.

breeding birds at Chester and Stuttgart, in Arkansas, which are for all practical purposes topotypes, and these belong unquestionably to the eastern form. From the above facts it is reasonably certain that Nos. 1865 and 1866 of the United States National Museum catalogue are the original specimens collected by Audubon near the Arkansas River, and that they came into Baird's possession and were duly entered by him in his catalogue. Since in size and color the one now marked No. 1865 in the United States National Museum collection is found to agree substantially with Audubon's original description, it may reasonably and properly be considered the type.

The second specimen marked as one of the types in the United States National Museum, and considered as such by Mr. Brewster, is an adult and bears on its original label in Baird's own handwriting the following inscription:

Tyrannula trailli? Aud
2960   n

This individual was evidently later received from Audubon by Professor Baird, as it was not entered in the catalogue until May, 1846, and then among a lot of other birds from the Columbia River received from Mr. J. K. Townsend. It will be noticed that the specimen was *doubtfully* identified by Professor Baird as *traillii;* and it was, without any reasonable doubt, one of the Columbia River examples obtained by Audubon from J. K. Townsend after the species was described.[†] That the Columbia River was its origin is further borne out by the fact that it is not subspecifically the same as the specimen here considered the type (No. 1865, U. S. Nat. Mus.), but is identical, as it should be, with birds from western Washington. It is apparently a female, though not sexed, and measures as follows: wing, 66 mm.; tail, 53; exposed culmen, 10.3; tarsus, 16; middle toe without claw, 9.5.

The third specimen mentioned by Mr. Brewster, No. 2039, U. S. Nat. Mus., is, as he states, in juvenal plumage, and was received by Professor Baird also from Audubon. It is, however, clearly an immature specimen of the Columbia River bird.

†*Cf.* Birds Amer., I, octavo ed., 1840, p. 235.

From the above facts it is very evident that the name *Empidonax traillii traillii* belongs to the eastern race, and that we must thus revert to the use of this name as it was before Mr. Brewster transferred it to the western bird; and by this change *Empidonax traillii alnorum* Brewster* now becomes a synonym.

Altogether 202 specimens of *Empidonax traillii traillii*, from the following localities, have been examined in the present connection:

Alaska.—Circle (July 12, 1903); Tatondu River, Yukon River (August 6, 1899); Charlie Creek, Yukon River (June 21, 1903); Nulato.

Alberta.—Smith Landing (June 15, 1901); Fort McMurray (August 11, 1903); 140 miles west of Edmonton (May 30, 1896).

British Columbia.—Vernon (June 5, 1895); Penticton (June 25, 1913); Hazelton (July 21, 1913); Okanagan Landing (June 18, 1915, August 18, 1915); Brackendale, Howe Sound (June 13 and 21, 1916, August 30, 1916).

Mackenzie.—Fort Resolution (June 30, 1865; June 22 and 24, 1903; June 19, 1903; July 10, 1903); Fort Simpson (July, 1861); Fort Rae (July 29, 1901); Nahannie River Mountains (July 13, 1903); Fort Good Hope (June 22 and 23, 1904); Hay River, Great Slave Lake (June 5, 6, 13, and 17, 1908); Fort Norman (June 13, 1904; June 30, 1903; July 4 and 24, 1908); Fort McPherson (July 9, 1904).

New Brunswick.—Grand Manan Island (July 4, 1907).

Ontario.—Mount Forest (June 13 and 29, 1892).

Saskatchewan.—Indian Head (June 24, 1895).

Yukon.—Fort Selkirk (July 26, 1899).

Arkansas.—Chester (June 4, 1910); Stuttgart (May 13, 1910).

Colorado.—Avalo (June 7, 1909,; Wray (May 21, 1909); Lake Station, Lincoln County, (May 27, 1905); Clear Creek, near Denver (June 4, 1911).

District of Columbia.—Washington (May 21, 1886; May 14, 1887; May 15, 1889; Sept. 9 and 17, 1890; August 31, 1890; May 18, 1892; Sept. 13, 1894; August 20, 1896).

Idaho.—Near Fernan Lake (Sept. 1, 1913).

Illinois.—Warsaw (May 3, 1884); Urbana (May 11, 1908); Areola (May 14, 1908); Richland County (May 21, 1883); Sugar Creek Prairie, Richland County (June 5, 1885; June 6,

*Auk. XII, No. 2, April, 1895, p. 161 (Upton, Maine).

1890); Canton (June 25, 1894); Lee (Aug. 8, 1907); Olney (Sept. 10, 1908).

Indiana.—Wheatland (May 21, 1885).

Iowa.—Clay County (July 3, 4, 13, and 17, 1907; August 7, 9, 13, and 19, 1907); Palo Alto County (July 13, 1907).

Maine.—Sebec Lake (June 1, 1907); Upton (June 11, 12, and 13, 1872); North Haven Island (June 16 and 19, 1907).

Maryland.—Laurel (May 16, 1888); Mountain Lake Park (July 3 and 4, 1899).

Michigan.—Isle Royale (July 14, 1905; August 26 and 30, 1905); Porcupine Mountains (July 22, 1905).

Minnesota.—Tower (June 14, 1895).

Missouri.—Grandin (June 3, 1907).

Montana.—Fort Keogh (May 28 and 31, 1889; June 2, 3, 4, and 8, 1889); Little Missouri River (June 6, 1916); Blackfoot Agency (June 13, 1895); Summit (June 19, 1895); Java (June 28, 1895).

New Hampshire.—Coos County (June 21 and 22, 1905).

New York.—Peterboro (May 21, 1886; May 21 and 30, 1887; June 2 and 3, 1887; July 19, 1886); Highland Falls (May 13, 1880; May 27, 1876); Kenwood (June 19, 1900).

North Dakota.—Lisbon (May 28, 1912); Pembina (June 3 and 9, 1873); Blackmer (June 5, 1915); Lidgerwood (June 18, 1915); Oakes (June 4, 1912; June 29, 1915); Kenmare (July 15, 1913); Dawson (July 21, 25, and 27, 1915; August 2, 1915); Lostwood Lake (August 16, 1915).

Ohio.—Wooster (June 20, 1892).

Pennsylvania.—Carlisle (May 20, 1845; May 31, 1841); Erie (May 21, 1894); Philadelphia (May 26, 1845).

South Dakota.—Smithville (May 31, 1894); Miner County (June 30, 1892); Evarts (August 6, 1903); Forestburg (August 10, 1906).

Texas.—Brewster County (May 8, 1913); Runge (August 24, 1905); Brownsville (August 27 and 28, 1912); Columbus (Sept. 4, 1905); Victoria (Sept. 12, 1906).

Virginia.—Four Mile Run (Sept. 2, 1894; May 10, 1894).

Wisconsin.—Madison (July 24, 1893).

Costa Rica.—Santa Maria de Dota (Feb. 29, 1866; May 11, 1908).

Nicaragua.—San Carlos (Feb. 25, 1892).

Oaxaca.—Huilotepec (May 12, 1895).

Empidonax traillii brewsteri, subsp. nov.*

Empidonax traillii pusillus AUCT. (nec Swainson).

Empidonax traillii traillii BREWSTER, Auk, XII, No. 2, April, 1895, p. 159 (nec Audubon).

Chars. subsp.—Similar to *Empidonax traillii traillii*, but bill larger, wing-bars darker, duller, much more brownish (less yellowish or greenish); upper parts decidedly more brownish or less greenish.

Description.—Type, adult male, No. 158360, U. S. Nat. Mus., Biological Survey collection, Cloverdale, Nye County, Nevada, May 31, 1898; Harry C. Oberholser; original number, 57. Pileum brownish olive, the centers of the feathers olive brown; the remainder of the upper parts between brownish olive and light brownish olive, but verging slightly toward olive, and paling on the shorter upper tail-coverts to light brownish olive; longest upper tail-coverts brownish olive; tail fuscous, margined externally on the basal portion with brownish olive; wings fuscous, the narrow external margins of tertials and secondaries tilleul buff, the margins of the lesser and median coverts brownish olive, the tips of the greater coverts between avellaneous and light drab; lores yellowish white, tips of the feathers olive brown; the sides of head and of neck rather light citrine drab, shading to buffy; sides of breast the same, but somewhat darker; chin and throat dull brownish white; jugulum and upper breast between grayish olive and deep olive buff; lower breast and abdomen naphthalene yellow; lower tail-coverts colonial buff; sides of body naphthalene yellow with an olivaceous tinge; thighs Saccardo's olive; edge of wing below, chamois; and lining of wing naphthalene yellow.

Measurements.—Type: wing, 69 mm.; tail, 60; exposed culmen, 12.5; tarsus, 16.5; middle toe without claw, 9.7.

Male:† Wing, 69–73 (average 70.6) mm.; tail, 56–60.5 (58.1); exposed culmen, 12.5–13.5 (13.0); tarsus, 15.5–17.5 (16.8); middle toe without claw, 9–10.5 (9.6).

Female:‡ Wing, 63–68.5 (65.7) mm.; tail, 52–60 (56.0); exposed culmen, 11.5–13 (12.2); tarsus, 15.5–17 (16.3); middle toe without claw, 9–10 (9.4).

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*Named for Mr. William Brewster.

†Thirteen specimens, from Oregon, California, Arizona, New Mexico, and Colorado.

‡Ten specimens, from Oregon, California, Arizona, and Utah.

Type locality.—Cloverdale, Nye County, Nevada.

Geographic distribution.—Western United States and extreme southwestern British Columbia, south to Mexico, Central America, and northwestern South America. Breeds chiefly in the Lower Austral, Upper Austral, and Transition zones of North America and Mexico; north to central Wyoming, central Idaho, northern Washington, and southwestern British Columbia; west to southwestern British Columbia, western Washington, western Oregon,, and western California; south to the extreme northern edge of Lower California, northern Sonora, Durango, southern New Mexico, and central Texas; and east to northeastern Texas, eastern Oklahoma, southeastern and central Colorado. Winters from northern Colombia to Panama, Costa Rica, and Nicaragua. Migrates east to eastern Nebraska, Tamaulipas, and Oaxaca; west to Sinaloa and Guerrero.

Remarks.—There is surprisingly little geographic variation within the range of this race, but birds from northern Washington and extreme southwestern British Columbia are somewhat intermediate, though not sufficiently so to cause doubt about their proper reference to this form. Birds from eastern Colorado and Texas likewise verge somewhat toward *Empidonax traillii traillii*.

There is, as in *Empidonax traillii traillii*, a large amount of individual variation in the present subspecies, including counterparts of the same six more or less well-defined color phases. The two patterns of coloration on the upper parts are even better indicated. In one of them the upper surface is nearly or quite uniform; in the other the pileum and cervix are much more grayish or brownish, and distinctly, even trenchantly, different from the back. The type of *Empidonax traillii brewsteri* is of the nearly uniform style. In specimens of each of these two patterns there are three definable phases of coloration. The upper parts may in color be either (1) normally dark and brownish; (2) yellowish brown on all but the pileum; or (3) distinctly gray. The yellowish brown phase is not so greenish as the corresponding plumage in *Empidonax traillii traillii*, and the gray phase is very much more purely grayish, less greenish. Furthermore, the lower parts are sometimes very strongly tinged with yellowish, particularly on the posterior portion; in other specimens this yellowish tinge is scarcely noticeable, except on the crissum.

Seasonal variation does not seem to be quite so strongly marked as in *Empidonax traillii traillii*, though summer birds are more brownish (less olivaceous) or more grayish, and paler than in autumn, spring or winter.

Birds in juvenal plumage, compared with the same stage of *Empidonax traillii traillii*, are usually lighter on the breast and more yellowish on the posterior lower parts, but some specimens are very difficult to distinguish.

The distinction between *Empidonax traillii traillii* and *Empidonax traillii brewsteri* has, of course, long been known. The name *Empidonax pusillus* (Swainson) was, until Mr. Brewster's investigations,* used for the latter, during which period the name *Empidonax traillii* or *Empidonax pusillus traillii* (Audubon) was employed for the eastern bird. The name *Empidonax pusillus* was taken from *Platyrhynchus pusillus* of Swainson,† which was described in the following language:

"Olive brown, beneath yellowish white; wings with two pale bands; tail moderate, even; bill small; head crested.

Maritime parts of Mexico.

Total length, $5\frac{1}{2}$; bill, $\frac{6}{10}$; wings, $2\frac{1}{2}$; tail, $2\frac{1}{4}$."

Swainson subsequently identified with this bird a specimen killed at Carlton House, Saskatchewan, and described and figured by him as *Tyrannula pusilla*‡, which is, as already stated by Mr. Brewster, very probably not this species at all, but *Empidonax minimus*. Even if the *Tyrannula pusilla* of Swainson be correctly identified as *Platyrhynchus pusillus* from Mexico, this does not aid in the solution of the identity of the latter, for the availability of the name must in this case be determined from the original description or from an examination of the type. As the above quotation shows, the original description of *Platyrhynchus pusillus* Swainson, while pointing toward the bird we have here described as *Empidonax traillii brewsteri*, is not certainly identifiable as such. Professor Alfred Newton made careful search among the Swainson types still remaining in the collection of the museum at Cambridge, England, but the type of *Platyrhynchus pusillus* is not there; nor apparently is it ever likely to turn up elsewhere. Therefore, as has already

*Auk, XII, No. 2, April, 1895, pp. 159–163.
†Philosophical Magazine, new series, I, No. V, May, 1827, p. 366.
‡Fauna Bor.-Amer., II, 1831 (1832), p. 144, pl. XLVI, upper figure.

been so well and fully stated by Mr. Brewster,* we are apparently justified in rejecting this name as unidentifiable.   This leaves the western bird, the *Empidonax pusillus* of authors and the *Empidonax traillii traillii* of Brewster, without a name, and we take pleasure in bestowing upon it herewith the name *Empidonax traillii brewsteri*, in recognition of Mr. Brewster's careful work on these very difficult flycatchers.

Two hundred and nine specimens of this subspecies have been examined, from the localities that follow:

British Columbia.—Victoria (June 4, 1892; June 13, 1894); Comox (July 11, 1895); Gibson Landing, Howe Sound (July 28, 1897).

Arizona.—Nogales (May 23, 1893); Santa Cruz River, Mexican Boundary Line (June 2 and 8, 1893); Alpine (August 1, 1915); Fort Whipple (August 10 and 15, 1864); Clifton (August 19, 1914); Lees Ferry (August 25, 1909); San Bernardino Ranch, Mexican Boundary Line (August 17, 1893; August 21 and 31, 1892; Sept. 5, 1892); San Francisco River (August 21, 1914); Pinal County (Sept. 3, 1883).

California.—Stockton (May 11, 1878; July, 1877); Mountain Spring, Mexican Boundary Line, San Diego County (May 13, 1894); Fort Mojave (May 21, 1861); Jacumba, San Diego County (May 23, 1894); Saticoy (May 24, 1873); Brawley (June 4, 1907); Kern County (June 8, ——); Owen Lake (June 9 and 12, 1891); Lone Pine (June 11, 1891); Hornbrook (June 15 and 16, 1897); Tulare Lake (June 20, 1907); Santa Barbara (June 25, 1875); San Bernardino (June 26, 1910); Kern River Lake (July 21, 1904, three nestlings); Donner Lake (July 25, 1900); Grafton (July 28, 1906); mountains near Camp Bidwell (July 31, 1878); Grizzly (August 11, 1900); Marshalls (August 18, 1905); San Clemente Island (August 23, 1894); Fresno Flat (August 30, 1904); Fort Tejon (August, 1875; Sept. 11, 1857); Bear Valley (1880).

Colorado.—Wray (May 22, 1911); Fort Garland (May 28, 1873); Arvada, Jefferson County (June 12, 1904); Loveland (June 26, 1891; July 26, 1895); Grand Junction (June 28, 1893); Colorado Springs (July 1 and 3, 1882); Breckenridge (July 2 and 8, 1877); Pueblo (July 23, 1874); Clear Creek, near Denver (August 6, 1911); Olivet, Jefferson County (August 8, 1911).

*Auk, XII, No. 2, April, 1895, pp. 160-161.

Idaho.—American Falls (June 3, 1911); Weiser (June 18, 1913); Birch Creek (July 22, 1890; August 4 and 15, 1890); Shelley (July 28, 1911); Van Wyck (August 16, 1913).

Nebraska.—Columbus (Sept. 1, 1892).

Nevada.—Pahranagat Valley (May 23, 1891); Glenbrook (May 30, 1889); Cloverdale (May 30 and 31, 1898); Mountain City (June 12, 1898); Winnemucca Lake (June 19, 1889); Ruby Valley (August 29, 1868); East Humboldt Mountains (Sept. 8, 1868).

New Mexico.—Las Vegas (May 23, 1900); Santa Rosa (May 26, 1903); Rinconada (June 1, 1904); Magdalena Mountains (August 30, 1909).

Oklahoma.—Dougherty (August 16, 1892); Hartshorn (Aug. 25, 1892).

Oregon.—Homestead (May 31, 1916; June 1, 1916); Salem (June 4, 1895); head of Whiskey Creek (June 14, 1897); head of Drew's Creek (June 17, 1897); Forest Grove (June 20 and 22, 1903); Portland (June 23 and 24, 1897); Fort Klamath (June 26 and 28, 1882; July 23 and 28, 1883); Jordan Valley (June 28, 1915); Looking-glass (June 29, 1916); Beulah (June 29, 1916); Beaverton (July 7, 1890); Reston (July 8, 1916); Juntura (July 8, 1916); Astoria (July 15, 1897); Rockville (July 16, 1915); Riverside (July 20, 1916); Shirk (July 22, 1896); Drew (July 28, 1916); Diamond (July 29 and 31, 1916); Telocaset (August 6, 1915); La Pine (August 11, 1914); Anchor (August 12, 1916); McEwen (August 20, 1915).

Texas.—San Angelo (April 8, 1885); Marathon (May 14, 16, 17, and 19, 1901); Brewster County (May 19, 1913); Tascosa (May 21, 1894; June 6, 1899); Laredo (May 23, 1866); mouth of Tornillo Creek (May 24, 1901); Fort Hancock (June 18, 1893); Boston (July 4, 1902); upper Devil's River (July 21, 1902); Texline (August 1, 1903); Pecos River, 55 miles northwest of Comstock (August 2 and 4, 1902); Pecos City (August 28, 1902); near Santa Rosa, Cameron County (Sept. 20, 1891).

Utah.—Mouth of Bear River (May 26 and 28, 1915; June 7, 1916; August 20, 1915); Antelope Island, Great Salt Lake (June 4, 1869); Ogden (June 15, 1872); Provo River (July 25 and 26, 1872); Parley's Park, Wasatch Mountains (July 28, 1869); Provo (July 26, 1872; August 2 and 3, 1872); Clear Creek (August 9, 1908).

Washington.—Fort Bellingham (May 27, 1905); Neah Bay (June 10, 1897); Prescott (June 18, 1908); Mount Vernon (June 24, 1897); Tenino (June 29, 1897; July 1, 1897); Granville (July 9, 1897); Steilacoom (August 1, 1856); Ellenburg (August 13, 1897); Tacoma (August 20, 1897).

Wyoming.—Stanley (August 23, 1911).

Costa Rica.—San Jose? (1873).

Durango.—Rio Nazas (June, 1853).

Guerrero.—Dos Arroyos (May 4, 1903).

Lower California.—Mount Mayor (May 24, 1915); Nachoguero Valley (June 1, 1894).

Michoacan.—La Salada (March 18, 1903).

Morelos.—Cuernavaca (April 9, 1908).

Nicaragua.—Sucuya (Feb. 7, 1883); Greytown (Feb. 8, 1892).

Oaxaca.—Tehuantepec (May 20, 1895); Huilotepec (May 11, 1895).

Panama.—Canal Zone (Jan. 14, 1912); Gatun, Canal Zone (March 6, 1911; May 8 and 15, 1911); Tabernilla (April 18, 1911); Porto Bello (May 26, 1911); Cana (May 23, 1912).

Sinaloa.—Mazatlan.

Sonora.—Nogales (June, 1855).

Tamaulipas.—Jaumave (June 2, 1898).

ADDITIONS TO THE CATALOG OF OHIO VASCULAR PLANTS FOR 1917.

JOHN H. SCHAFFNER.

66. **Tsuga canadensis** (L.) Carr. Hemlock. Bainbridge, Ross Co. E. N. Transeau.

71. **Pinus echinata** Mill. Shortleaf Pine. Bartles, Lawrence Co. A. E. Taylor; Ironton, Lawrence, Co. Lillian E. Humphrey; Marietta, Washington Co. Forest W. Dean.

72. **Thuja occidentalis** L. Arborvitæ. Bainbridge, Ross Co. E. N. Transeau.

74. **Juniperus sibirica** Burgs. Low Juniper. Two specimens growing on "Fort Hill," Berea, Cuyahoga Co. E. L. Fullmer.

76. **Taxus canadensis** Marsh. American Yew. Under arborvitæ and hemlock trees. Bainbridge, Ross Co. E. N. Transeau.

256.1. **Carex swanii** (Fern.) Mack. Swan's Sedge. In woods. Sunbury, Delaware Co. Frank T. McFarland.

321.1. **Uniola latifolia** Mx. Broadleaf Spike-grass. Bainbridge, Ross Co. E. N. Transeau.

365. Change name of **Triticum vulgare** L. to **Triticum aestivum** L.

452. **Syntherisma ischaemum** (Schreb.) Nash. Small Crabgrass. Gallipolis, Gallia Co. John H. Schaffner.

874. **Viola lanceolata** L. Lanceleaf Violet. Ironton, Lawrence Co. Lillian E. Humphrey.

1214. **Ampelopsis cordata** Mx. Heartleaf Ampelopsis. Gallipolis, Gallia Co. John H. Schaffner.

1323. Change name from **Opuntia humifusa** Raf. Western Prickly-pear, to **Opuntia opuntia** (L.) Coult. Common Prickly-pear.

1400. **Andromeda polifolia** L. Wild Rosemary. Akron swamps, Summit Co. E. L. Fullmer.

1433.1. **Convolvulus repens** L. Trailing Bindweed. On steep bank. Hillsboro, Highland Co. Katie M. Roads.

1471. **Frasera carolinensis** Walt. American Columbo. Barnesville, Belmont Co. Emma E. Laughlin.

1571.   **Cymbalaria cymbalaria** (L.) Wettst.   Kenilworth Ivy.
          Berea, Cuyahoga Co.   E. L. Fullmer.
2046.   **Lactuca sagittifolia** Ell.   Arrowleaf Lettuce.   Parma
          Twp., Cuyahoga Co.   E. L. Fullmer.

Additions made to the Cedar Point flora during the summers
of 1914–1916, by E. L. Fullmer.

Sagittaria brevirosta Mack and Bush.   July 6, 1914.
Salsola pestifer A. Nelson.   July 27, 1915.
Cerastium velutinum Raf.   June 21, 1916.
Agrostemma githago L.   June 22, 1916.
Camelina microcarpa Andrz.   June 22, 1916.
Thlaspi arvense L.   June 25, 1914.
Cucumis melo L.   June 8, 1914.
Hypochaeris radicata L.   July 23, 1916.
Tragopogon pratensis L.   July 27, 1915.
Sonchus arvensis L.   July 27, 1916.

THE

OHIO JOURNAL OF SCIENCE

TABLE OF CONTENTS

THE EXPRESSION OF SEXUAL DIMORPHISM IN HETEROSPOROUS SPOROPHYTES.*

JOHN H. SCHAFFNER.

The writer has been engaged for a number of years in studying the evolutionary development of the higher plants. In the study of the flower, the problems of sexuality and of sporophyte dimorphism have presented themselves in an unusual manner, with many hints as to the nature of their hereditary expression.

The most remarkable dimorphism in plants is, of course, the difference of form and function expressed between gametophyte and sporophyte. One can hardly conceive of a more fundamental difference than exists, for instance, between the two generations of the ordinary ferns. In the higher plants this dimorphism is as extensive as sexuality itself. Sexual dimorphism seems more prominent to us only because we constantly associate our ideas with the sexual dimorphism of the higher animals.

Aside from the dimorphisms mentioned above there are also very striking vegetative dimorphisms which have no relation to sexuality or the alternation of generations. Such vegetative dimorphisms are usually expressed in different parts of the same individual. In plants like Megalodonta beckii (Torr.) Greene and Neobeckia aquatica (Eat.) Britt., the dimorphism is

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*Contribution from the Botanical Laboratory, Ohio State University. No. 99.

related to the environment, the submerged leaves being dissected and the aerial leaves of the ordinary broad type, characteristic of closely related genera and species.   In Lepidium perfoliatum L. there is just as abrupt and striking a change at the middle of the stem although there is no change in the surrounding medium.   The lower leaves are finely dissected, while the upper are entire, oval in shape, and deeply clasping.

These dimorphisms are changes of states or expressions of hereditary units in the common tissue of a growing shoot. It is plain that they have to do with activity and latency rather than with the presence and absence or the shifting of hereditary units.   This fact is to be kept in mind further on in the discussion of analogous sexual phenomena.   Similar dimorphisms, although usually not so abrupt, are, of course, very general in great numbers of rosette plants.   There are also cases where there is an abrupt, new development of shape, structure, and often color in the leaves just below the inflorescence.   This type of vegetative dimorphism is especially common in the Euphorbiaceæ.

Among the fungi and many other organisms another type of dimorphism is common, which often involves not only the reproductive cells, but also the surrounding hyphæ.   In the Ascomycetæ there is generally a decided difference between the conidial and ascus stages.   These differences appear in different branches of an individual mycelium.   The difference in sexual and nonsexual reproductive parts of such fungi corresponds to the vegetative dimorphisms mentioned above in that the phenomena are not associated with shiftings of the chromosomes.   In some cases they are produced at rather definite stages of the life cycle, in others the change of expression depends on the environment.

Now what is meant by sexuality?   In its simplest form it is a physiological difference expressed only in the developing sexual cells.   As we go up the scale of plant complexity, we note that more and more of the tissues are involved until finally in the extreme forms the entire organism seems to be affected. From the evidence to be presented it must become apparent that in at least the vast majority of cases, and probably in all, the sexual condition is simply a state of the living substance which may continue for a greater or less length of time before a neutral state or the opposite sex condition is set up.

Physiological states may be due to chemical or other causes. Among the conditions in which organisms may be growing or living, the following may be mentioned: An active or quiescent state; vigorous or exhausted; sterile or fertile; immunity to disease at a certain age or susceptibility; specific diseased condition, like cretinism in children, or normal; gametophyte or sporophyte (without change of chromosome number); female or male; carpellate or staminate; juvenile state or mature state (like certain Acacias and Junipers); water form or air form; root state or stem state (usually with change of environment); conidial stage or sexual; protonema or scaly moss plant; difference of unusual morphological expressions without any hereditary difference, as for example, two or more very different types of insect galls on the leaves of celtis occidentalis L. In the case of the transition from gametophyte to sporophyte and vice versa, there is usually a change in the chromosome number which might be assumed to be the cause of the remarkable change in morphological expression, but there are many examples in both mosses and ferns, and also in the flowering plants, where the change takes place in the vegetative tissues without a shifting of chromosomes. The study of apogamy and apospory should shed much light on the nature of sexual and nonsexual states.

Before presenting the evidence in hand on the development of dimorphism in the heterosporous sporophytes a few general facts may be given in relation to sex as expressed in the gametophyte. The term sex used in its strict sense applies both to diploid and haploid individuals; among animals to diploid and among plants more commonly to haploid individuals, although there are numerous algæ in which the life cycle is essentially similar to that of the animals.

As already stated, there is a gradual development from a condition where no difference is apparent between the conjugating cells except the mutual attraction at a certain period to highly specialized cells, and further through hermaphordite organisms with strikingly different sexual organs on different parts of the same body up to completely unisexual individuals. In the past it has been assumed that sexuality was evolved because of some fundamental utility to the organism, but the doctrine of specific utility as an explanation of origins can have little place in the theory of any investigator who has carefully

studied the facts of plant evolution. The utilitarian view as developed to a supreme position in the Darwinian theory is largely discordant with present day views, but still seems to have a tenacious hold on the philosophy of sex. Things may be useful but the cause of their origin and persistence is another question. One can find endless cases where exactly opposite developments occur side by side in closely related species and varieties subject to a common environment. For example, note the barbed involucral bristles of Chaetochloa. In Chaetochloa verticillata (L.), Scrib. the barbs are retrorse while in the closely related Chaetochloa viridis (L.) Scrib. they point outward. In neither case have they any relation to seed distribution since the bristles remain on the dead inflorescence when the spikelets fall. In the genus Bidens, the papus awns are usually barbed, but here also some species have retrorse barbs and some outwardly projecting barbs. Since the awns are persistent on the fruit the retrorse barbs become useful but the others, if they have any effect must rather hinder seed distribution. In some species of Bidens the awns have no barbs whatever. Any number of similar cases could be cited.

Sex appears in some way to be associated with physiological and chemical states of the living protoplasm. It is perhaps most reasonable to assume, at present, that a certain organization or complexity of the cell is necessary before sexual states originate. But it is not true on the other hand that these states are necessarily set up at any stage of the life history even in organisms that have the essential complexity.

Among plant gametophytes the greatest sexual difference is shown in the Spermatophyta, between the male and the female. In the Archegoniata, very striking examples are certain species of Polytrichum where the mature male plant has a very different appearance in form and color from the female. The difference is much greater than is exhibited by many mammals or even birds. Now, just as in the gametophyte generation we find no vegetative dimorphism in the lower forms but find this becoming more and more pronounced as we ascend the scale, so also in the evolution of the sporophyte it is only the extreme forms in the evolutionary series that show but the one state throughout the entire individual. It is evident also that the gametophyte is far advanced in evolution

before the appearance of heterosporous sporophytes and that
it shows complete sexual segregation from the Heterosporous
Pteridophytes on up, while as stated, comparatively few
sporophytes have attained complete individual dimorphism.

The gametophytes of Homosporous Pteridophytes exhibit
both hermaphrodite and unisexual species, and in the case of
certain unisexual ferns and horsetails, various experimenters
have shown that the sex can be controlled or reversed after it
is determined. The reversal can be brought about in either
direction, but generally a much larger per cent. of females
can be induced to produce male reproductive organs than
males can be changed to females. This is probably due to
the more specialized nature of the male soma, especially in
relation to nutrition and vegetative growth. It is well to call
attention here again to the fact that when the higher hetero-
sporous plants developed definitely unisexual, gametophyte
individuals, the segregation of the sexes was not accomplished
in or by the reduction division, as one might have expected, but
entirely independently of that process. All the four spores of a
reduction division have the same sexual tendencies and all give
rise either to male or to female gametophytes. Here the
development of males and females is associated with the size
of the spores. It is also interesting to note that in animals
the spermatocytes through reduction give rise to four spermatids
which develop into spermatozoa without any reference as to
whether they contain an allosome or not. If the allosome is
what determines sex, how is it that the two spermatids without
allosomes develop maleness in exactly the same extreme way
as the two which contain the allosome? Certainly the peculiar
morphology of the spermatozoon must be considered maleness,
if there is such a thing. The same reasoning would apply to
the egg cell. In the case of the honey bee, all the oocytes
develop eggs, which we certainly must admit is a female expres-
sion; yet these same eggs without fertilization change their
sexual expression and develop into male individuals. In
animals we cannot test out the hereditary qualities of the
spermatozoa independently as we can the microspores of plants.
If we could we would probably obtain results analogous to those
coming from the androspores of certain species of Oedogonium,
which give rise to dwarf males. In the higher plants than
reduction of chromosomes has nothing to do with the maleness

and femaleness of the gametophyte.   The determination of the
sex takes place in the vegetative tissues of the sporophyte.
Whatever it is that determines that the given tissue shall
develop as a megasporophyll or a microsporophyll also deter-
mines absolutely the sex of the following generation of game-
tophytes.   We are dealing with the establishment of a state
in the cells of a vegetative tissue.   A moment's reflection
will show how extremely inappropriate is the application of the
terms, homozygous and heterozygous in relation to sex indivi-
duals.   Sexuality is just as pronounced in haploid gameto-
phytes as elsewhere.   The males, females and hermaphrodites
of the higher plants can not be "zygous" at all in the normal
life cycle.   They are the results of segregation rather than of
conjugation.   The vast majority of sporophytes are bispor-
angiate and are of course homozygous or heterozygous in their
chromosome condition, but here the sex is determined in the
vegetative tissue before spores are produced.

In some species of Bryophytes it has been claimed that two
of the cells of the reduction tetrad normally give rise to males
and the other two to females.   In such cases the sex must be
determined in the spore mother cells (daughter cells of the
sporocyte).   But a sexual state might be influenced by unequal
distribution of the cytoplasm.   In great numbers of Bryophytes,
however, the gametophyte is hermaphrodite and the establish-
ment of the sexual state necessarily takes place in the vegetative
cells of the gametophyte.   Recently Allen[*] has reported a
difference in size in one pair of chromosomes in the spore mother
cells of Sphaerocarpos.   Even if such a difference can be
associated with a specific sex difference, it does not necessarily
follow that the sex condition is determined by an irreversible
sex factor in the given chromosomes.   However, in this case
where the sex individuals are haploid, such a hypothesis would
be much more convincing than in the case of the diploid animals.

In dealing with sexual phenomena in plants, the problem is
always complicated by the presence of an antithetic alternation
of generations.   Because of a confusion in terminology coming
from a past period when the nature of the plant life cycle was
unknown, it is often difficult to correlate the meaning of expres-
sions used by different writers, especially of those who disregard

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[*]Allen, Chas. E. A Chromosome Difference Correlated with Sex Difference
in Sphaerocarpos. Science 46 : 466–467. 1917.

modern morphological discoveries.   We cannot hope to analyze hereditary phenomena unless we have a correct understanding of the morphology and physiology of the parts under considera- tion.   In recent years a consistent terminology has been developed by morphologists and there is no excuse for not using it.   We have a sporophyte terminology and a game- tophyte terminology.   However, when applied to the new science of genetics out language is still inadequate, and one is immediately confronted with the difficulty of expressing hereditary phenomena in relation to sex when the sporophyte of heterosporous plants is involved.   The homosporous sporo- phyte having no sexual dimorphism does not raise the issue, but when passing from homosporous to heterosporous spor- ophytes the problem presents itself with the common solution that organs formerly described and defined as without sex now obtain a radically different treatment, to the confusion of both the learned and the unlearned.   It seems to the writer that the way out of the difficulty, at present, is to employ the sporophyte terminology when structures are mentioned, and to limit the sexual terminology, as far as possible, to the states or conditions of special gametophyte phenomena expressed in the sporophyte.   Thus a spore bearing fern leaf is a non- sexual structure and a sporophyll of Marsilea is still nonsexual although it produces spores of two sizes.   But the difference between the spores is a sexual difference.   A carpel is still a megasporophyll and a nonsexual reproductive organ of the same fundamental nature as the megasporophyll of a hetero- sporous pteridophyte, but it is a sporophyll in which the sexual phenomena peculiar to the gametophyte are finding expression. The sexual state is thrown back, so to speak, into a small part of the sporophyte.   It is this spreading of the sexual state, with an ever increasing area of the tissue involved, that con- stitutes one of the most interesting aspects of sporophyte evolution in the higher plants.

So far as the writer knows, Marsilea is the lowest living genus of heterosporous plants in respect to sexual dimorphism of the sporophyte.   In external aspect the sporophyte shows no dimorphism, the sporocarps all being alike (Fig. 1).   But the sporangia are slightly different, although the same in general shape.   The most striking difference is in the stalks.   The stalk of the microsporangium is comparatively long and slender,

while that of the megasporangium is short and thick. (Figs. 2 and 3). The dimorphism appears very pronounced in the spores. There is a remarkable difference between the microspores and megaspores in shape and size. There is here also the difference in spore development, in that the cells from the microspore tetrad all develop while only one of the cells of the megaspore tetrad develops. There is only one spore in the megasporangium in marked contrast to the large number in the microsporangium. Here then is a beginning of sexual dimorphism in the sporophyte. Now how is this difference in morphologic expression in the sporophyte tissue coming about? It is not by any shifting of chromosomes evidently; the tissues have a common vegetative origin side by side. The two kinds of sporangia do not even occupy different regions of the modified leaflet which bears them. It is the setting up of a differential condition of the same general nature as that which determines a dimorphic expression in the hard tissue of the sporocarp and the membranous tissue of the leaf blade on the same petiole.

Shattuck† found both in the normal plants and in all the cultures that a close examination revealed a homosporous tendency in that microspores were sometimes formed in the megasporangia, especially in those most distant from the nutritive supply. He also found that in cases of abortion in the microsporangia only one spore survives which is about sixteen times as large as the normal microspore. Shattuck discovered a method by which the nature of spore development in Marsilea can be controlled to a certain degree.

In the second stage of dimorphic advancement, as is well illustrated by Selaginella kraussiana (Kunze), the strobili are bisporangiate and each type of sporangium is confined to a separate leaf. There are definite microsporophylls and megasporophylls. In this species of Selaginella there is only one megasporophyll, at the base of the cone, to about twenty microsporophylls. The tissues which develop the two types of sporophylls are definitely located. Dimorphism of spores and sporangia is present as in Marsilea, but there are usually four megaspores. When we examine the blades of the sporophylls we also find a slight difference. They are both green and

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†Shattuck, C. H. The Origin of Heterospory in Marsilea. Bot. Gaz. 49 : 19-40. 1910.

of the same texture, but somewhat different in shape and size.
(Figs. 4 and 5). Here the dimorphic state has spread far
beyond the spores and sporangia, until it affects the differ-
entiation over a considerable area. The microsporangiate
and megasporangiate states are set up in the incepts of the
sporophylls. In the one case we have male determination,
in the other female. Again, how is this determination brought
about? By the activity and latency, whether only partial or
complete, of hereditary factors. The sexual differentiation
takes place before and outside of the phenomena of the reduction
division and fertilization. It has absolutely nothing to do with
segregation or association of chromosomes or allosomes.

In the gymnosperms generally the dimorphism is expressed
not only in a difference in shape, size and structure of the
sporophylls, but usually also in a difference in color; and since
the cones are usually monosporangiate in the living species, the
dimorphism extends to the floral axis or even beyond. But
as all of these advancing evolutionary stages are also repre-
sented in the Anthophyta, no special consideration will be
given here to the sexual dimorphisms of the gymnosperms.

When we come to the lowest Anthophyta, as in various
genera of the Ranales, there is a considerable advance over the
condition in Selaginella and related plants. Figures 6 and 7
represent a stamen and a carpel of Aquilegia canadensis L.
The dimorphism appears in the shape, size and color of the
sporophylls and in addition the megasporophyll shows that
remarkable secondary sexual character, the stigma, which
becomes necessary here because of the closed condition of the
carpellate blade. The ovulary is also covered with prominent
hairs while the stamen is smooth, a sex-limited character. In
this case the sexual dimorphism expressed in parts of the
sporophyte is about as great in character and degree as is usual
for secondary sexual differentiations either of plants or animals.
But the difference is confined to the sporophylls. The spor-
ophyte as an individual shows but one form and nature and the
dimorphism is developed in closely associated organs arising
from a common tissue. The condition as represented by the
flowers of Aquilegia canadensis L. is the normal state for the
flowering plants. Indeed, if defined in general terms, the
Anthophyta are plants with bisporangiate flowers with here
and there groups or individual species which have advanced in
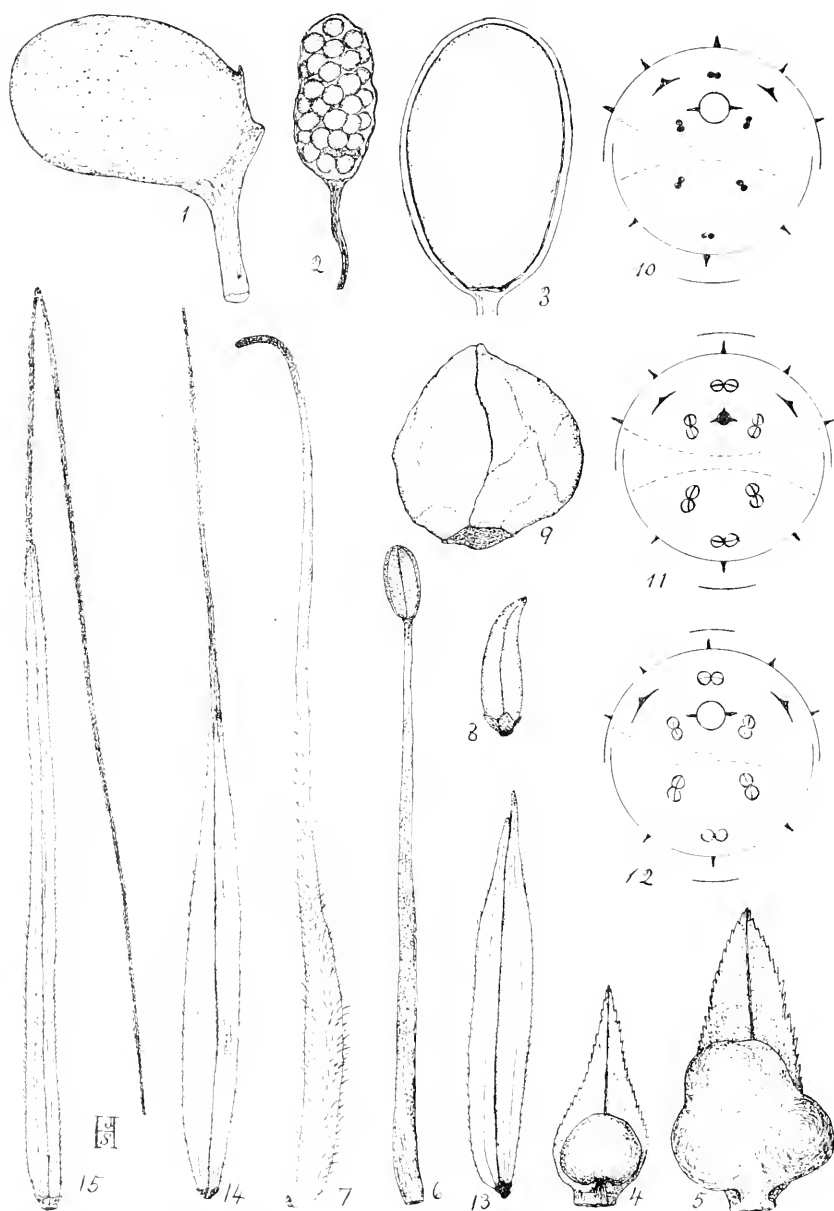
specialization to a greater or less degree toward the monecious or diecious state.   In tracing from the bisporangiate to the monosporangiate flowers one finds a most remarkable display of vestigial structures, which are the result of suppression of the opposite hereditary factors by the distinctive sexual condition set up in the tissues from which they should develop.   This inhibitory influence is of every degree of intensity in various species, ranging from cases where the organ is almost normal to its entire disappearance.   In the more primitive, or rather less specialized species, reversions are very common.

The strictly diecious state is comparatively rare.   There are no original monosporangiate flowers among the Anthophyta. The few examples, in which all vestige of a bisporangiate condition has disappeared, in nearly every case show a direct relationship to species or groups with the opposite structures present either as vestiges or in a normal condition.   A few examples will be given to show the general trend of development to a typical diecious condition.   It is well, however, to caution against the notion that the monecious condition is a step in the evolution of the diecious.   It may be in some cases but mostly the development of diecious plants comes about directly through a succession of more extreme vestiges.

Sagittaria latifolia Willd., a low species of the Helobiæ and closely related to the bisporangiate genus, Echinodorus, is an example of a plant which has taken but a slight step toward the monecious condition.   In typical cases the inflorescence bears

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EXPLANATION OF FIGURES 1–15.

Fig. 1.   Sporocarp of Marsilea quadrifolia L.
Fig. 2.   Microsporangium from the same.
Fig. 3.   Megasporangium from the same.
Fig. 4.   Microsporophyll of Selaginella kraussiana (Kunze).
Fig. 5.   Megasporophyll from the same strobilus.
Fig. 6.   Stamen of Aquilegia canadensis L.
Fig. 7.   Carpel from the same flower, showing hairs on the ovulary, a sex-limited character.
Fig. 8.   Staminate flower bud of Cocos nucifera L.
Fig. 9.   Carpellate flower bud from the same inflorescence.
Fig. 10.   Diagram of carpellate spikelet of Zizania aquatica L.
Fig. 11.   Diagram of staminate spikelet from the same inflorescence.
Fig. 12.   Diagram of a bisporangiate spikelet from the middle zone of the same inflorescence as Figs. 10 and 11.
Fig. 13.   Staminate spikelet of Zizania aquatica L., showing lack of awn.
Fig. 14.   Bisporangiate spikelet from the same inflorescence, showing awn of intermediate length.
Fig. 15.   Carpellate spikelet from the same inflorescence as Figs. 13 and 14, showing long awn, a sex-limited character.

the carpellate flowers below and the staminate above on a common scape, although the entire inflorescence may be staminate or carpellate.   There is not much difference in the corresponding perianth segments, but there is a difference in the receptacle.   The staminate flower contains a half dozen or so of vestigial carpels whose imperfection would hardly be suspected unless compared with a normal carpel from a carpellate flower.   The carpellate flower contains much more reduced vestigial stamens.   In general, one can not predict which set of organs will be the more reduced in any given species though it is generally true that the carpellate flower is more apt to retain stamen structures than the staminate flower is to retain vestiges of the gynecium.   This agrees with our notion that maleness in general is a more extreme condition than femaleness, but there are many exceptions like Sagittaria. As to the area involved in the dimorphic state, Sagittaria is rather extreme in that the inflorescence is divided into definite carpellate and staminate regions.   However, there are many species of plants in which the two types of flowers are intermingled throughout the entire inflorescence.   In the cocoanut, Cocos nucifera L., the flowers are monosporangiate and monecious.   The diphorism of the flowers, which are situated on the branches of a large inflorescence, is very great.   (Figs. 8 and 9).   Both flowers have distinct vestiges of the opposite set of organs.   The dimorphism extends out to the perianth. The sepals of the staminate flower are small and short, while those of the carpellate flower are large and cover the entire bud.   The petals of the staminate flower are narrow while those of the carpellate flower are broad.   Figures 8 and 9 are sketches of unopened buds drawn to scale and show plainly how the dimorphic condition is expressed in the tissues far beyond the sporangia.   It is interesting to note that the vestigial carpels of the staminate flower are only slightly united, while those of the carpellate flower are completely syncarpous.   The inhibitory staminate condition does not permit a complete union and a more primitive condition, apocarpy, is expressed.   In the carpellate flower the stamen vestiges are small; however, one occasionally finds flowers in which one or more stamens are rather prominent.   The writer discovered one case in which a vestigial stamen had developed a nearly perfect anther and the other five vestiges were larger than usual.

A further advance in the extent of the dimorphism is shown
by those plants in which the distinctive staminate and car-
pellate flowers are confined to definite parts of the same inflor-
escence.   A good example of this condition is the wild rice,
Zizania aquatica L.   This is a monecious species with the
flowers in a large panicle.   The upper part of the inflorescence
is carpellate and the lower staminate.   The change in condition
usually extends transversely across the inflorescence axis and
its branches.   The staminate spikelets have a vestigial gynecium
with three minute stigmas, while the carpellate spikelets have
six distinct vestigial stamens.   Here we have a considerable
extent of tissue involving a large number of spikelets in the
same sexual state.   The amount of the vegetative tissue involved
is much greater than in cases like the cocoanut.   But the most
striking peculiarity of this inflorescence is in the central part.
Here the spikelets are bisporangiate having perfect stamens and
gynecia.   (See diagrams, Figs. 10, 11, 12).   On the transition
zone neither state is established and so no inhibition occurs.
The sexual state is brought about in the sporophylls as is usual
in bisporangiate plants in general as well as in the lower grasses.
Examples like Zizania show plainly that the determination of
staminate, carpellate, and bisporangiate flowers takes place in
the vegetative tissues by the establishment of a certain physio-
logical state and has nothing to do with gross or cellular mor-
phology.   The fundamental morphological conditions, both
gross and microscopic, are the same throughout the entire
panicle.

Zizania aquatica has also a remarkable sex-limited char-
acter.   The lemmas of the staminate spikelets are awnless while
those of the carpellate spikelets are long-awned.   The bispor-
angiate spikelets in the neutral region have short awns.   (Figs.
13, 14, 15).   There is every gradation of length of awn in pass-
ing from the awnless lemmas of the staminate region to the
long-awned lemmas of the carpellate region.   No matter
whether one or many awn factors are involved, the character of
the awn is due entirely to the latency or activity of the awn
factor or factors under the influence of the sexual state.   Here
then we have plain evidence of the nature of sex limited char-
acters in plant sporophytes.   Both awnless and awned lemmas
have a common sporophyte heredity, but this heredity expresses
itself in all degrees of latency and activity depending on the

sexual state of the tissue involved.   If we hold to the reasonable hypothesis that the presence of a positive character is due to the presence of a factor or group of factors, then the absence of an awn on the staminate lemma is due to latency caused by the presence of the male condition in the given cells.

The relative position of the staminate and carpellate flowers in the inflorescence is reversed in various genera from what it is in the wild rice.   In the aroids the staminate flowers are
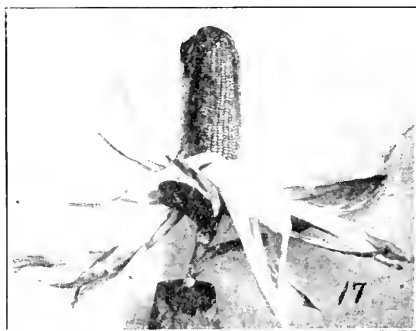

Fig. 16.   Staminate inflorescence of Zea mays L.
Fig. 17.   Carpellate inflorescence of Zea mays L.

usually above and the carpellate below.   In the gama-grass, Tripsacum dactyloides L., the same is true and the two regions of the inflorescence show a very remarkable dimorphism.   The lower part, containing the carpellate spikelets is remarkably modified.   The dimorphism exists not only in the flowers and glumes but extends into the stem.   The modified carpellate spikelets are enclosed in pockets, formed of highly modified joints of the stem which develops cleavage planes, the joints being separated at maturity, giving rise to very remarkable fruits.

The next step in the evolutionary progression of sexual dimorphism may be represented by Indian-corn, Zea mays L. Here as is well known the typical plant has a terminal staminate inflorescence, and one or more carpellate inflorescences developed from the side of the stem. (Figs. 16 and 17). The difference between the two branches is remarkable although they consist of the same morphological elements. The carpellate branch shows by far the greater deviation from the general vegetative morphology. The main differences are as follows:

Staminate stem.	*Carpellate stem.*
1. Normal internodes.	1. Internodes greatly shortened.
2. Normal sheaths.	2. Sheaths changed to husks.
3. Leaf blade normal.	3. Leaf blade absent or vestigial.
4. Inflorescence of comparatively primitive type, branched.	4. Inflorescence modified, with loss of branches.
5. Axes normal.	5. Axis a cob.
6. Character of glumes, membranous and elongated.	6. Character of glumes, chartaceous and broad.
7. Staminate flower.	7. Carpellate flower.
8. Little or no vestige of gynecium.	8. Remarkable development of style and stigmas (Silk).
9. Normal stamens.	9. Minute or no vestiges of stamens.
10. Microsporangia,	10. Megasporangia.
11. Microspores.	11. Megaspores.
12. Ordinary color in floral axis and glumes.	12. In some varieties, red or other color in floral axis and glumes.

The writer recently received an interesting ear of popcorn from Mr. L. E. Thatcher which shows a zonal arrangement of the sexual condition. This ear is a normal side ear with the lower part typically developed. In the middle is a complete zone, about an inch long, of staminate spikelets, while the outer part is typical ear structure again with normal grains. In this case there is a successive reversal of the growing axis. First the axis develops a cob with normal carpellate spikelets, then changes suddenly to a staminate condition and finally resumes its growth in the carpellate state.

The buffalo-grass, Bulbilis dactyloides (Nutt.) Raf. is a perennial, monecious grass with stolons which root at the nodes. According to Plank* and to Hitchcock† any given node produces but one type of inflorescence, and each kind of stolon is supposed to propagate its own kind. If this is true, the buffalo-grass would be an interesting plant for experimentation.

*Plank, E. N. Buchloe dactyloides Engelm. not a Dioecious Grass. Bull. Torr. Bot. Club. 19 : 303. 1892.
†Hitchcock, A. S. Note on Buffalo Grass. Bot. Gaz. 20 : 464. 1895.

The final step in the development of sexual dimorphism of the sporophyte is attained in the diecious condition.   But here again some species are more definitely diecious.   There are very few strictly diecious plants.   Diecious sporophytes are isolated developments arising from parallel evolutions scattered from one end of the Anthophyte phylum to the other.   In every instance they are derived from bisporangiate ancestors.   In some cases as will be shown below the entire transition may occur in a single genus.

Fig. 18.   A mature, dying, staminate plant of Cannabis sativa L., grown in the winter.
Fig. 19.   A blooming, carpellate plant of Cannabis sativa L. of the same age as Fig. 18.

A good example of a diecious species is the common hemp, Cannabis sativa L.   The plants are staminate and carpellate with other differences in the flowers besides the sporophylls. The carpellate plants are more robust and much longer lived. Figures 18 and 19 represent two plants of dwarf size raised in the middle of winter in the greenhouse.   The plants photographed were transplanted to pots when mature.   These abnor-

mal plants usually showed not more than five to seven leaf
nodes, while plants raised in poor soil during the summer
showed as high as twenty nodes.   The staminate plant was
dying of old age when photographed, although less than four
months old.   In plants like the hemp, the sexual dimorphism is
as great if not greater than in the ordinary mammals.   In fact,
in many mammals it is much more difficult to recognize the
sexes by somatic characters.

Among these hemp plants there were intermediates as is
common in most diecious species.   Staminate plants with more
or less carpellate expression were considerably longer lived and
more robust than those which were purely staminate.   Not
only did typical staminate plants sometimes produce bispor-
angiate flowers with more or less normal gynecia but some
carpellate plants even produced stamens.   This in spite of the
fact that the plants were differentiated in their vegetative parts
as typically carpellate.   In plants grown later, out of doors,
from the same seed no abnormalities were seen, but as the
plants were not examined when they first began to bloom they
may nevertheless have been present.   The great abundance of
intermediates in the winter, greenhouse plants was probably
due to the abnormal environment, mainly a lack of light.   The
point to be emphasized in this connection is that we have here
a diecious plant which shows sexual dimorphism even in its
remote vegetative parts, but numerous individuals which are
thus specialized have the ability to produce the opposite primary
sexual generation and sexual cells, without any manipulation
whatever being employed, except that they were grown in an
unusual environment.   How extremely impossible it would be
in this case to claim that the specific sex characters were due
to sexual Mendelian units, one individual being homozygous
for sex and the other heterozygous.   The whole behavior in
these diecious plants is essentially the same as the sexual dif-
ferentiation in the less extreme cases, traced above from Marsilea
to Indian-corn.   The maleness and femaleness represent states
which inhibit to a greater or less degree the development of the
opposite organs the heredity of which is potentially present,
since both the staminate and carpellate plants do produce both
male and female gametophytes.   Dieciousness is a differential
state, hereditary, of course, in the ordinary sense, which permits

under ideal conditions only the one set of spores and organs to
be expressed, although the hereditary abilities for the other set
are all present.   The morphological expression is brought about
in the same way as such a differential development takes place
in the tissues of bisporangiate sporophytes, either with
monecious or bisporangiate flowers.
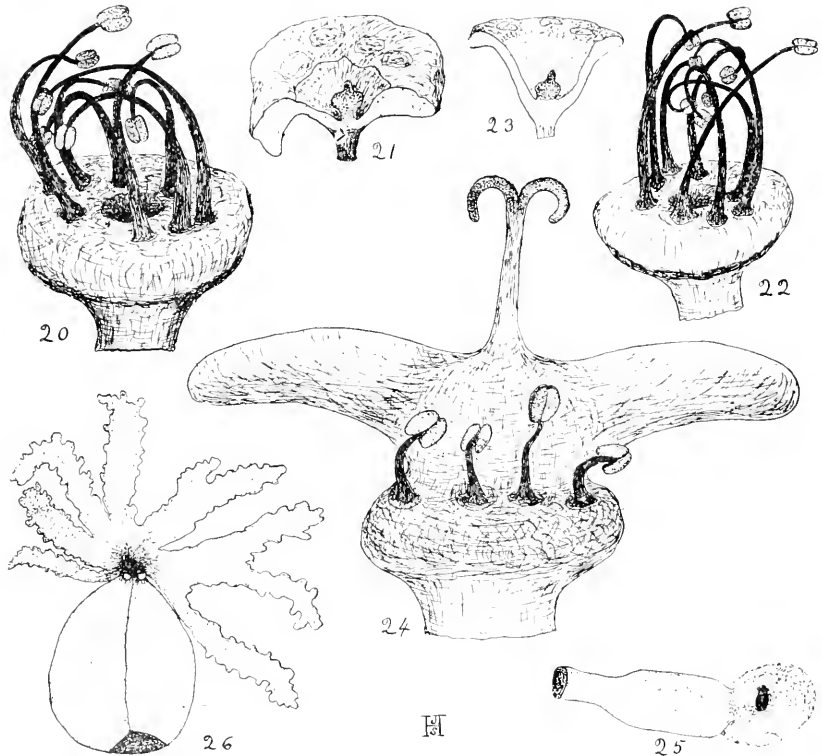
EXPLANATION OF FIGURES 20–26.

Fig. 20.   A staminate flower, with perianth removed, from a carpellate tree of
          Acer platanoides L.
Fig. 21.   Part of the same flower, showing the vestigial gynecium.
Fig. 22.   Staminate flower, with perianth removed, from a staminate tree of
          Acer platanoides L.
Fig. 23.   Part of the same flower, showing the vestigial gynecium.
Fig. 24.   Fruiting carpellate flower, with perianth removed, from the same tree
          as Fig. 22, showing normal young samara and vestigial stamens.
Fig. 25.   Tip of a staminate flower of Rumex acetosella L., showing one of the six
          stamen filaments and the small vestigial gynecium with three minute
          vestigial stigmas.
Fig. 26.   Gynecium from a carpellate flower of Rumex acetosella L., showing one
          of the three, large, branched stigmas, the other two being removed.

The genus Acer presents a very good series, passing from Acer platanoides L. through a number of species to Acer negundo L., the boxelder. So far as the writer's observations go, the boxelder is strictly diecious. Acer platanoides is in a much more primitive condition being but a short distance removed from the normal bisporangiate type. However the plants are staminate and carpellate. The writer has found carpellate trees which developed a few typical staminate flowers with vestigial gynecia and normally developed stamens, although the trees were covered with young fruit from the normal carpellate type of flower. (Figs. 20 and 21). Staminate trees were also discovered which were producing many carpellate flowers with vestigial stamens (Figures 22–24). These carpellate flowers developed normal fruit. Figure 24 represents a partially developed fruit. In both cases the percentage of the unexpected kind of flowers was small, but the staminate trees produced a much larger per cent. of carpellate flowers than the carpellate trees did of staminate flowers.

Rumex is another genus which begins with a partial bisporangiate state and ends in a diecious condition. Rumex crispus L. has bisporangiate flowers and carpellate flowers, the latter containing prominent vestigial stamens. Rumex acetosella L. is strictly diecious. The carpellate plant shows no vestige of the stamens or else these are too small to be seen without making special sections. But the staminate flower shows a small vestigial gynecium with three minute stigmas. (Fig. 25). The persistence of the three vestigial stigmas may be accounted for by the fact that the normal stigmas of Rumex are very large and branched. (Fig. 26). In some of the intermediate species of Rumex, as for example Rumex altissimus Wood, the vestigial stamens are rather prominent and the vestigial gynecium is of fair size with three small slightly branched stigmas.

A most striking example to illustrate the stages in the evolutionary development of dieciousness is presented by the genus Fraxinus. Fraxinus cuspidata Torr. has flowers with corolla and calyx. They are bisporangiate and very fragrant. Fraxinus quadrangulata Mx. has bisporangiate flowers, but no perianth. The merest vestige of a calyx is present. Fraxinus americana L. has a minute calyx and is strictly diecious. If the antiquated and misleading classification of the flowering

plants, still generally in vogue, could be eliminated, more botanists might realize the fact that monecious and diecious species are the extremes and commonly the culmination points of numerous parallel series rather than the first stages of Angiosperm evolution.

One more example will be given to illustrate the progressive differentiation of larger areas of staminate and carpellate tissues in an ascending phyletic series. In the Cyperaceæ the least specialized genera have bisporangiate flowers, like the genus Scirpus. Some of the species of this genus have a fairly well developed vestigial perianth of six segments. There are no special structures difficult to interpret. But in the genus, Carex, the perianth is absent and there is present the peculiar perigynium and other unusual structures. Carex is monecious; usually with staminate and carpellate flowers apparently without vestiges of the opposite organs. In Carex nardina Fries. the spikelets are all alike containing carpellate flowers below and staminate flowers above. In the highest sedges like Carex lupulina Muhl. the monosporangiate flowers are on separate spikelets, the staminate spikelets above, the carpellate spikelets below. In Carex, therefore, we approach the condition present in Indian corn.

What is the nature and cause of this progressive change in the area of the tissue involved? In the first case mentioned above, the differentiation takes place in the sporophylls on the same floral axis; in the second case the floral axes produce each but one kind of sporophylls, but the two kinds of flowers are on the same inflorescence axis; in the third case an entire spikelet or group of spikelets is similarly affected. The whole matter can only be interpreted, if at all, by a study of the evolutionary series of expressions in related species. Isolated studies do not give a true picture; in fact do not present the problem. But in no study could the phenomena of segregating or associating chromosomes be involved but the much more difficult problem of changing hereditary expressions and states in a common vegetative tissue.

As an example of the changes of morphological expression that take place in a growing bud, an ordinary grass may be considered, like Bromus secalinus L. The grasses are derived from plants whose buds produced three spirals of leaves in the vegetative parts as well as in the flower, the ancestral flower

being a trimerous, pentacyclic structure. In the sedges the leaves are still in three spirals, but in the grasses they are in two; in other words, the leaves of the grasses are two-ranked. During the vegetative growth of Bromus, therefore, its bud gives off alternately incepts of leaves on opposite sides of the stem. These leaves are differentiated through the activity of hereditary units into the form characteristic of the species. This two-ranked arrangement is a culmination type of morphological expression. As stated, the species evolved from ancestors in which three spiral incepts were successfully organized instead of two. Now the cells of the terminal bud actually contain the hereditary ability to develop threes as will appear below. But for some cause the ability is suppressed. The bud, using a metaphor, dances a two-step instead of a waltz. When a spikelet begins to develop, the two-ranked condition continues and the two-ranked empty glumes are produced and a number of flowers, also in two ranks. The flower bud on the spikelet also produces two-ranked glumes, the flowering glumes, unless the palet represents more than one leaf. But the first set of floral organs proper, the lodicules are produced in a three spiral arrangement. The third, or posterior one, however, is suppressed in harmony with the bilateral nature of the evolved plant. One step down in the evolutionary scale, in the bamboo tribe, the third lodicule is present in the proper position as it should be in a monocotyl flower. In some way the bilateral nature does not act so intensely as in Bromus and the higher grasses in general. The lodicules probably represent a corolla, the calyx being suppressed. Next the flower bud of Bromus not only develops three incepts in typical tripartite arrangement, alternate with the lodicules, but these organs pass into that strange state which determines the nature of stamens and male gametophytes with male cells or sperms as the final goal. Now all of this up to the formation of microsporocytes is a matter of vegetative growth. The cells in the stamens have received the same heredity as those which produced leaves, glumes, or lodicules. The three stamens are the only structures which show the typical ancestral morphology in the entire life cycle of the grass under consideration. Next the bud fails to perform and the second, expected set of three stamens does not develop. In many bamboos all the six stamens are present, as in any typical monocotyl that is not specialized too much.

Finally the bud does another "three-step" forming a united tricarpellary gynecium, but here again the third stigma on the outside in the bilateral plane is suppressed.   All three stigmas are usually present in Arundinaria and other bamboos.   At the same time the incept of the gynecium has set up in its cells a sexual state just the opposite from that of the andrecium immediately below although so far as any one knows and so far as the evidence goes these cells have received exactly the same hereditary units as have those of the leaves, the glumes, the lodicules, and the stamens.   But in some way a new physiological state has been established which causes the heredity to give rise to a new morphological expression along with femaleness.

At each whorl there is a difference in hereditary expression, a change in the activity and latency of numerous hereditary factors.   This change in activity and latency, the writer believes is due to changes in physiological state of the tissues involved, whether chemical or otherwise.   The progressive changes of morphological expression in a vegetative tissue do not find their explanation in any Mendelian formulæ.   Mendelian ratios, segregations and associations have no direct bearing on the problem.   Just as these profound changes in the vegetative development are brought about by some state in the cells which influence the hereditary activity, so essentially similar changes in physiological activity bring about sexual expressions, causing the cells or tissues to give rise to male or female morphological structures with their accompanying sexual activities.

It may be that in some cases physiological states or hereditary factors may arise in an allosome or special chromosome which may assist in retaining and intensifying a male or female state already established, but so far as the writer can see the animal kingdom presents the same problems of changes in sexual states in common tissues as does the plant kingdom.   The lower animals are hermaphrodites and the higher unisexual forms are after all only modified hermaphrodites.   Sex-limited and sex-linked transmission can readily be explained without postulating a sex-determining allosome, with no more complexity of hypotheses than if such mendelizing units are assumed.   And it must always be kept in mind that with the assumption of sex-determining chromosomes the greater

part of sexual phenomena becomes unexplainable and con-
tradictory. The presence of allosome difference in certain
sexual individuals does not make it necessary for us to amend
the proposition that sexuality either male or female is a state
or condition and not a mendelian factor or set of factors.

For the convenience of those who wish to make a study
of our more common or interesting species, the following short
list is given as an index to the general condition usually present
in monecious and diecious plants:

Four genera to illustrate the relation of diecious to
bisporangiate species—Thalictrum, Rumex, Acer, Fraxinus.

Thalictrum clavatum DC.   Flowers bisporangiate.

Thalictrum dasycarpum Fisch. & Lall.   All gradations of bisporangiate
to staminate and carpellate flowers on the same plant.

Thalictrum dioicum L.   Plants diecious.

Rumex crispus L.   With bisporangiate flowers and carpellate
flowers containing prominent vestigial stamens on the same plant. The
stigmas are much branched.

Rumex altissimus Wood.   Monecious. The carpellate flowers have
six vestigial stamens; the staminate flowers have a vestigial gynecium
with three slightly branched stigmas.

Rumex acetocella L.   Diecious. The staminate flower has a minute
vestigial gynecium with three, unbranched, vestigial stigmas; the
carpellate flower apparently has no vestigial stamens; the stigmas are
much branched.

Acer platanoides L.   Imperfectly diecious. Some carpellate trees
have staminate and some staminate trees carpellate flowers; both kinds
of flowers have prominent vestiges of the opposite organs. The flowers
have large petals and a prominent nectar disk.

Acer saccharinum L.   Diecious. Carpellate flowers with vestiges of
stamens; staminate flowers with vestigial gynecia. Some plants
occasionally have bisporangiate flowers. The petals are absent.

Acer negundo L.   Strictly diecious. The flowers are much reduced
and have no vestiges of the opposite organs.

Fraxinus cuspidata Torr.   Flowers bisporangiate with a calyx and
corolla; very fragrant.

Fraxinus americana L.   Strictly diecious. Flowers small without
corolla but with a small calyx; no vestiges of the opposite sporophylls.

List of a few monecious and diecious species with notes on the condition of the reciprocal organs in the two types of flowers:

Sagittaria latifolia Willd. Monecious, occasionally diecious. The staminate flower has prominent vestigial carpels, only slightly different from the fertile carpels of the carpellate flower. The carpellate flower has minute vestiges which, no doubt, represent stamens.

Sagittaria rigida Pursh. Monecious. The condition of the flowers is the same as in S. latifolia.

Phoenix dactylifera L. The carpellate flower has six vestigial stamens; the staminate flower has three vestigial carpels.

Cocos nucifera L. Monecious. The carpellate flower has six minute vestigial stamens, one or more of which occasionally develop nearly normal anthers; the staminate flower has three prominent, only slightly united, vestigial carpels.

Typha latifolia L. Monecious. The flowers are much reduced and neither type shows any vestiges of the opposite organs. More primitive related genera, belonging to the Pandaneæ, show vestigial structures.

Arisæma triphyllum (L.) Torr. More commonly diecious. Spadixes occur which have only carpellate flowers; some have carpellate flowers with a few imperfect staminate flowers at the top; some have normal carpellate flowers below and normal staminate flowers above; some are almost entirely staminate with two or three normal carpellate flowers situated in about the middle of the spadix; and some are entirely staminate.

Panicum virgatum L. Each spikelet contains a bisporangiate and a staminate flower.

Zizania aquatica L. Monecious; with staminate spikelets below and carpellate spikelets above, on the inflorescence; the carpellate spikelet contains six vestigial stamens; the staminate spikelet contains a vestigial gynecium. In the transition tissue there are normal, bisporangiate spikelets. The awns are sex-limited, depending on the degree of the carpellate condition.

Andropogon furcatus Muhl. In each pair of spikelets, the sessile spikelet is bisporangiate; the stalked spikelet is staminate with a vestigial gynecium.

Tripsacum dactyloides L. Monecious; with the carpellate spikelets below and the staminate above. The carpellate flower with three vestigial stamens; the staminate flower with a vestigial gynecium.

Smilax hispida Muhl. Diecious. The carpellate flower has six vestigial stamens; the staminate flower contains no vestige of the gynecium.

Dioscorea villosa L. Diecious. The carpellate and staminate flowers contain vestiges.

Thalyctrum dasycarpum Fisch. & Lall. On the same plant may be found purely carpellate flowers, purely staminate flowers, carpellate flowers with one stamen, staminate flowers with one carpel, and all gradations between, some flowers having about half of each kind of organs. Some species of Thalictrum are diecious.

Menispermum canadense L. Diecious. The carpellate flower has about twelve vestigial stamens; the staminate flower has no vestiges.

Sassafras sassafras (L.) Karst. Diecious. The staminate flower has a vestigial carpel; the carpellate flower has six staminodes.

Zanthoxylum americanum Mill. Usually diecious. The staminate flower has prominent vestigial carpels, the carpellate flower sometimes has minute vestigial stamens.

Ptelia trifoliata L. Imperfectly monosporangiate and imprefectly monecious. The staminate flower has a prominent imperfect gynecium; the carpellate flower has five vestigial stamens.

Ailanthus glandulosa Desf. Diecious. The carpellate flower has ten prominent staminodes; the staminate flower has a prominent vestigial gynecium of five carpels.

Napea dioica L. Diecious. The carpellate flower has a vestigial stamen column; the staminate flower has no vestige.

Rumex acetosella L. Diecious. The staminate flower has a small vestigial gynecium with three minute stigmas; the carpellate flower has no vestiges.

Aruncus aruncus (L.) Karst. Diecious. The carpellate flower has vestigial stamens; the staminate flower has three vestigial carpels.

Gymnocladus dioica (L.) Koch. Diecious. The carpellate flower has ten large staminodes; the staminate flower has a vestigial carpel.

Acer negundo L. Apparently strictly diecious with no vestiges of the opposite organs. In the lower species of Maples the trees are imperfectly diecious and the flowers have very prominent vestiges of the opposite organs.

Morus rubra L. Diecious. Staminate flowers with a vestigial gynecium; carpellate flowers without vestiges. Often there are staminate and carpellate catkins on the same tree; sometimes there are carpellate and staminate flowers on the same catkin; sometimes a carpellate catkin may contain a single staminate flower.

Cannabis sativa L. Diecious; but the plants are of various degrees; some carpellate plants may have stamens and staminate plants may have carpels.

Populus deltoides Marsh. Apparently strictly diecious, as also some willows, but there are intermediate willows, occasionally.

Cucumis sativus L. Monecious. The carpellate flower has three vestigial stamens; the staminate flower has a tricarpellate, vestigial gynecium.

Diospyros virginiana L. Usually diecious. Carpellate flower with vestigial stamens; staminate flower with a large vestigial gynecium.

Fraxinus americana L. Apparently strictly diecious. Various species of Fraxinus present gradations from bisporangiate, conspicuous flowers to diecious flowers with loss of perianth and nectar glands.

Ambrosia trifida L. Monecious. The staminate flower has a vestigial gynecium; the carpellate flower shows no vestiges of stamens.

EUTETRAMORUS GLOBOSUS, A NEW GENUS AND SPECIES OF ALGÆ BELONGING TO THE PROTOCOCCOIDEA (Family Cœlastridæ).

L. B. WALTON.

While studying the plankton from "Mirror Lake," a small pond on the campus of the State University at Columbus, Ohio, exceedingly rich in phytoplankton at certain times of the year, a form quite unique in structure was noted with much interest. It consisted of 16 cells, each containing a chloroplast, the cells being arranged in groups of fours and imbedded in an almost invisible gelatinous matrix. The organism was non-motile with no trace of flagella. The preparation was one taken from a
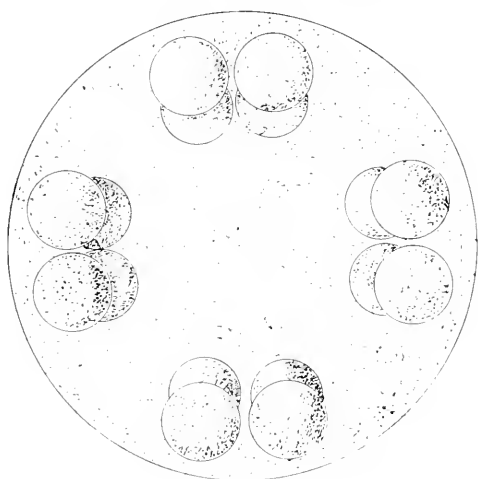
Eutetramorus globosus n. g., n. sp.   (x2000.)

sterilized specimen bottle filled with water and floating algæ— mostly Cladophora—at the margin of the lake, Oct. 9, 1915, the observation being recorded a few days later. An interval of over two years has elapsed during which period various samples of water from the lake have been studied without again noting the species however.

The organism is referable to the Family *Cœlastridæ* (*Cœlastraceæ*) of the *Protococcoidea** and constitutes a new genus quite different from forms thus far known. The drawing (Fig. 1)

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*The endings of the Class and Family names are identical with those utilized in a systematic review of the typically unicellular forms which will be published shortly. They are an extension of those proposed by Poche (1911). Nomenclatural methodology, particularly among the primitive plant-animal organisms is in a somewhat chaotic condition.

is taken from a camera lucida sketch made at the time with a Leitz Binocular, 2 mm. apochromatic objective.

Eutetramorus n. g.

Cells non-motile, light chlorophyl green; united into a colony of 16 cells arranged in groups of 4's within a gelatinous like mucous covering; plane of each series of 4 cells perpendicular to the square included by the groups.

Represented by a single species.

E. globosus n. sp.

Cells spherical, containing a chloroplast with central pyrenoid, the 16 cells united in groups of 4's, the distance between each group and the adjacent lateral group being approximately one and one-half times the diameter of the individual cell; reproduction unknown.

Diam. (single cell 5μ. (colony) 30μ.

Distribution, Mirror Lake, Columbus, Ohio (U. S. A.).

Habitat, surface water at margin of lake.

The relationship of the form to *Cœlastrum* and the other allied genera of the family seems clear, although the systematic position must be a provisional one until the method of reproduction is known. In its organization it represents the lowest form of the family where a definite colonial organization is attained.

Kofoid (1914) has recently described a new genus and species, *Phytomorula regularis*, from a reservoir at Berkeley, California, which is allied to *Cœlastrum* and is of unusual interest in that it represents a 16 celled colonial form extremely flattened, the cells being contiguous although not arranged in the same plane. The species was extremely rare and he had been unable, at the time of the presentation of the paper, to obtain informa- tion as to its method of reproduction.

The family *Cœlastridœ* now consists of five genera which may be separated in accordance with the table given below. Three of the genera have an extremely restricted distribution which, however, may be the result of their comparatively rare occurrence. *Eutetramorus* is based on a single specimen obtained at Columbus, Ohio. *Phytomorula* is described from a very few specimens obtained in a reservoir at Berkeley, California.

Burkillia is known only from Burma.   The remaining two
genera, *Cœlastrum* and *Sorastrum* are abundant and have a
wide distribution.   The genus *Hariotina* based by Dangeard
(1889) on *H. reticulatum* is now included with *Cœlastrum* while
Selenosphærium of Cohn (1879) is placed with *Sorastrum*.

TABLE OF GENERA.

A¹   Cells comparatively smooth or at least not developing acute processes
      or spike-like appendages; colonies with cells regularly arranged,
      usually approximating the form of a sphere, which may be extremely
      flattened.
      B¹   Colonies formed of 16 cells; form not that of a true sphere.
             C¹   Cells arranged in groups of fours, the groups not con-
                   tiguous; colony not flattened............1.   Gen. **Eutetramorus**
             C²   Cells not arranged in groups of fours; contiguous; colony
                   flattened.............................2.   Gen.   **Phytomorula**
      B²   Colonies formed of 2–32 cells; form approximately spherical.
                                                    3.   Gen. **Coelastrum**
A²   Cells developing acute processes or provided with acute or spike-like
      appendage processes; colonies with cells not regularly arranged, not
      approximating the form of a sphere.
      B¹   Cell walls gradually narrowed into an acute process.
                                                    4. Gen. **Burkillia**
      B²   Cells provided with spike-like appendages or elongate processes.
                                                    5.   Gen. **Sorastrum**

BIBLIOGRAPHY.

1915.   **Brunnthaler, J.**   Die Susswasser-Flora Deutschland, Oesterreichs, und der
        Sehweitz, Hft. 5, p. 1913. (G. Fischer, Jena.)
1914.   **Kofoid, C. A.**   *Phytomorula regularis*, A Symmetrical Protophyte related
        to Coelastrum.   Univ. of Calif. Pub., Botany, V. 6, No. 2, p. 35-40, Pl 7.
1907.   **West, W. and West, G. S.**   Fresh-water Algae from Burma, including a few
        from Bengal and Madras.   Ann Roy. Bot. Gard. Calcutta, V. 6, Pt. 2.
1916.   **West G. S.**   Algae, p. 205 and 243 (Cambridge University Press, Cam-
        bridge, England.

Kenyon College, Gambier, Ohio, December 5, 1917.

A STUDY OF CATTLE "TEMPERAMENT" AND ITS MEASUREMENT.

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INTRODUCTION.[*]

The present phase of this problem has been evolved from an attempt to correlate the so-called "dairy temperament" with milk production. The term "dairy temperament" was first promulgated by Ex-Gov. Hoard of Wisconsin in 1886, in a lecture on "Nervous or Dairy Temperament in Cattle." He called it a predisposing tendency in the animal to convert its food either into milk or flesh." He called that temperament pertaining to dairy cattle, "dairy temperament." A later definition of the term was expressed by Prof. Hæcker, of Minn.: "An animal whose nervous system dominates the vital system, has the inherited tendency to convert the nutriment in food into milk." "Dairy temperament" today, is one of the strongest points of the dairy cow score card. The term and its definition are based on indications only, such as "eye full and expressive," "clean face," "large nostrils," "long, light neck," "sharp withers," "prominent spinal column," etc.

The word "temperament" is perhaps a rather ambiguous term to apply to cattle, but it was employed, no doubt, for want of a better word. The usual definition of the word characterizes it as a mental condition, or "special type of mental constitution and development or mixture of characteristics, supposed to have its basis in the bodily organism and to be transmissible by inheritance,"[†] or again a "natural disposition." Speaking of disposition, psychologically it is a "tendency left behind by an experience, to give rise on suitable stimulation, to a reaction which shows the influence of that experience, especially as applied to explain the phenomena of memory." The

term "dairy temperament," as it has been used, is based entirely upon physical characteristics of the animal, and as such is abstract and unusable. It is the purpose of this study to attempt to measure "temperament" in cattle, and so place it upon a quantitative basis.

Historical.—In the study of human psychology, many experiments have been carried on by which various emotions, and mental and nervous disturbances have been registered. According to C. S. Stumpf—"our conscious states, without our willing it—indeed, even in spite of us—are accompanied by bodily changes, which very often can be detected only by the use of extremely fine graphic methods." (10) These have been based mainly, but not solely on respiration. Respiration in animals is controlled almost entirely by the nervous system, the respiratory center being located in the medulla oblangota. Connected with it is the vagus center, which in turn receives nerves from the lungs, heart and stomach. The respiratory movements are controlled primarily by the nerves to the inter-costal muscles and diaphragm. The nerves supplying these muscles do not come from the respiratory center, but come from the cells of the grey matter of the spinal cord. It is by influencing the activities of these cells, that the respiratory center controls the act of respiration. In its turn the respiratory center is under control of the higher nerve centers of the brain. Due to the afferent nerves from the viscera and sense organs, as well as from the higher brain centers, respiration is influenced by the heart beat, activities of the stomach, and internal organs, as well as by external changes. The automatic activity of the respiratory center is chiefly regulated by the amount of acid in the blood and the temperature of the blood. Therefore the respiratory movements are also regulated by the metabolic activities of the animal. As the rate of the heart beat accelerates, so, too, does the rate of respiration. Respiration then is not a separate activity, but is in harmony with, and closely allied to various other physical and mental activities. Respiration has been found to be a good index to the nervous reactiveness and "temperament" of an animal, and has formed the chief basis of this study, being used as a means of measuring "temperament" or nervous reactiveness. As Zoneff and Neumann say: "Insoeben wurde ich bei gelegentlichen Ver-suchen, auf den Unterschied aufmerksam, den das Athem mit

dem Brustkorb und die Zwerchfellathmung beim Ausdruck der
Gefühle zeigen.   Ueberall, wo in unsern Versuchen der Athem
charackteristische Veränderungen aufweist, finden sich analoge
Erscheinungen im Puls." (12).

It can be shown by suitable curves recorded while the
animal is resting, that there is a fundamental rhythm in the
respiratory movements, which is peculiar to each individual.
Ordinarily this rhythm is obscured because external and
internal stimuli affect respiration to a very large extent.   It
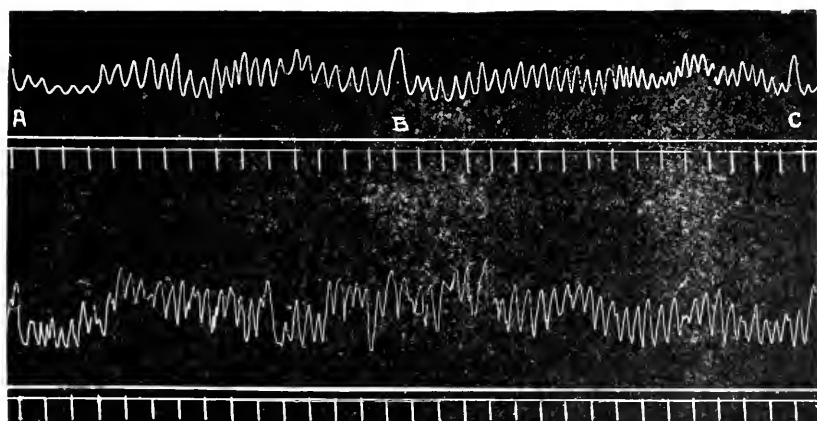has been our experience, that those animals which were least

Fig. 1.   Respiration tracings of 7H (above) and 2H (below) recorded while
feeding.   At A, B and C are shown the deep expirations.   This type of
respiration recalls the Cheyne-Stokes breathing sometimes seen in man,
and is typical of resting animals or those which have a stolid disposition.
The contrast between these tracings illustrates very well the difference
between the respiration of a stolid and nervous cow.   Time intervals,
five seconds.

nervous and most easily handled, showed this fundamental
rhythm very often; and further, that the fundamental rhythm
of these very stolid animals showed a very low variability when
compared with rhythms of more nervous ones, (see Figure 1).
As a result of considerable preliminary work and experience
with animals concerned, we have confined this study to the
measurement of the variability of the depth of breathing, shown
by four Holstein cows, which were tested as nearly as possible
under the same normal stable conditions.

METHODS AND PROCEDURE.

An apparatus, similar to that used upon human beings, was employed, with but a few minor modifications which adapted it to use with cattle. This consisted of a pnuemograph, kymograph, tambour, electric clock and signal magnet, which were connected in the usual manner. The tambour registered the respiratory activities upon a drum fitted with smoked paper, which revolved at a convenient rate. The speed was so timed that the curves were easily read, and showed the minutest variations. In all curves, the signal magnet registered five second intervals below each curve. In every curve the up stroke indicates expiration and the downstroke inspiration. These pneumographic tracings, (see Figure 1), not only registered respiratory movements, but also outward movements of the animal's body, such as kicking, moving about, movements of the head, switchings of the tail, etc. The pneumograph was attached about the barrel of the animal, nearly over the diaphragm. In this position, all or nearly all of the movements were recorded. As has been shown, every movement is controlled by the nervous system and so has a direct bearing upon the measurement of nervous activity. Thus a restless animal showed a greater number of variations in its curve than a more quiet one.

Four registered Holstein-Friesian cows were experimented with—Seven H, Three H, Two H, and Five H. Three periods of the day were selected for experimentation, which represented three given conditions—before feeding, during feeding and after feeding. Curves were made with the different animals on different days under these conditions, over a period of three months. After becoming familiar with the apparatus and subject, each variation in the curve proved significant of some definite activity. We were soon able to recognize kicks, swallowing, switching of tail, etc., as recorded on the drum. Our experience is in accord with that of Neumann, who says: "Es zeigte sich bei diesen Versuchen, dass der Athem das empfindlichste Reagens bei Gefühlschwankungen bildete, und das bei richtiger Behandlling der pneumographischen Registierapparate die Athemveränderungen als sicherestes Kennzeichen alle Veränderungen der Gefühlslebens dienen können." (12.)

RESULTS.

Treatment.—After sufficient data had been collected, (about 150 curves), a method of interpreting the pneumographic tracings was used, whereby respiratory activities and the corresponding variations were taken into account. The amplitude of each inspiration and expiration was measured in millimeters, and these measurements were tabulated statistically, and the data plotted in the form of a frequency polygon, where the amplitudes of respirations were plotted against their frequencies. The mean (M), standard deviation (S. D.), coefficient of variability (Cv.), and their corresponding probable errors, were calculated according to the usual formulæ.

Many such frequency polygons were made of the different subjects, under different conditions, and taken from different days selected at random. After a sufficient number of such polygons from each animal were plotted, the entire number of polygons of each individual under a given condition, were constructed into a composite curve or polygon, which latter was taken as characteristic of that animal under the given condition. The composite was constructed in the following manner. The means of the individual polygons were superimposed upon each other, and then each polygon was plotted about its own mean. Then, for example, where the various lines of amplitude 4 crossed the different frequency lines, a simple average was taken, and this average represented the average frequency of amplitude 4, and was plotted as such upon the composite. From the composite, another set of figures was derived, and this taken as characteristic of the given subject under the given condition. And so the mean, standard deviation, and coefficient of variability of the composite were taken as representative. This method of constructing composites was made necessary by the curious moving of the mean up or down (see below), and by variations in pressure in the pneumograph and tambour due to changes in tension and positions of the same.

TABLE I.

Showing the means, M., standard deviations, S. D., and coefficients of variability, Cv., of the respiration composites of the four cows under the experimental conditions, before, during, and after feeding.

ANIMAL NUMBER	BEFORE FEEDING	FEEDING	AFTER FEEDING
Seven H......	M. 6.4101 ± .067 S.D. 2.025 ± .047 Cv. 31.59 ± .813	M. 10.422 ± .080 S.D. 2.581 ± .057 Cv. 24.76 ± .579	M. 5.349 ± .077 S.D. 2.204 ± .054 Cv. 41.20 ± 1.17
Three H......	M. 6.698 ± .089 S.D. 2.570 ± .063 Cv. 38.369 ± 1.06	M. 9.122 ± .084 S. D 2.607 ± .067 Cv. 28.57 ± .791	M. 7.21 ± .100 S.D. 3.042 ± .070 Cv. 42.19 ± 1.14
Two H........	M. 6.732 ± .133 S.D. 3.098 ± .094 Cv. 46.02 ± 1.669	M. 9.971 ± .132 S.D. 3.796 ± .094 Cv. 38.07 ± 1.064	M. 9.093 ± .137 S.D. 3.458 ± .097 Cv. 38.02 ± 1.213
Five H........	M. 8.227 ± .155 S.D. 4.154 ± .109 Cv. 50.49 ± 1.67	M. 11.97 ± .174 S.D. 5.162 ± .123 Cv. 43.124 ± 1.20	M. 7.92 ± .120 S.D. 3.096 ± .085 Cv. 39.08 ± 1.22

Individual Variation.—For clearness and convenience, two sets of comparisons will be made; first, variations within the individual, and second, variations within the group. As stated above, each subject was experimented upon under three different conditions, before, during and after feeding. In order to facilitate comparisons, all three polygons have been plotted upon one sheet, i. e., those which pertain to the individual animal; and at the same time the coefficients of these curves, the mean, standard deviation and coefficient of variability with their probable errors are shown in Table I.

The general appearance of the composites of all the individuals would lead one to believe that the coefficient of variability is the key to their interpretation. The coefficients do bear a relation to the shape of the curve, but in their interpretation they cannot be considered alone, but must be interpreted in terms of the mean and standard of deviation, otherwise they are misleading. For example, the after feeding polygons of Seven H and Three H, (Fig. 3) are entirely different, and a single glance would tell that the polygon of Three H is more variable than that of Seven H, and yet their coefficients of variability are practically the same, 42.19 and 41.20 respectively. But considering the means and standard deviations, this is easily

explained, that Three H is more variable than Seven H under the same condition. The mean of Three H is 7.21 and that of Seven H is 5.34, which shows that Three H had a large number of respirations about 7 mm. in length, while Seven H had a large number of respirations about 5 mm. in length. Their standard deviations, 3.04 and 2.20 respectively, are more significant, since they show that Three H deviated more from its mean, than Seven H did from its mean. Now combining the respective means and standard deviations of each individual, it is seen that the mean and standard deviation of Three H increased in about the same ratio, and hence the coefficients of variability are practically alike, since by formula:

—coefficient of variability = $\dfrac{\text{standard deviation}}{\text{mean}}.100.$

But the fact remains that Three H is more variable than Seven H, under the given condition, even though their coefficients of variability do not show as marked difference as the polygons themselves indicate.

Further, the fact that the mean and standard deviation of Three H increased in the same ratio, is explained by the condition under which the tracings were made. This was not constant. Above it was stated that the animals were subjected to like conditions, but these conditions were not constant so far as the time element is concerned. For sufficient reasons, as will be explained later, the after feeding condition was not always taken at a specific interval after the regular feeding time. This, as will be seen, affects the means of the polygons, and in turn the coefficient of variability. As the pneumographic tracings of the after feeding condition were taken farther from or nearer to the regular feeding time, the resulting polygons here plotted moved farther from or nearer to the "o" ordinate, due to the increasing or decreasing depths of breathing as the case may be. The reason that the mean should vary directly with the time of taking the after feeding tracings, is probably due to the metabolism of the animal which also varies as the after feeding condition draws near to or farther from the actual feeding time. Consequently, the time element not being constant, the means varied to such an extent as to make the coefficients of variability misleading, and so the standard deviation is of more consequence than the mean in interpreting
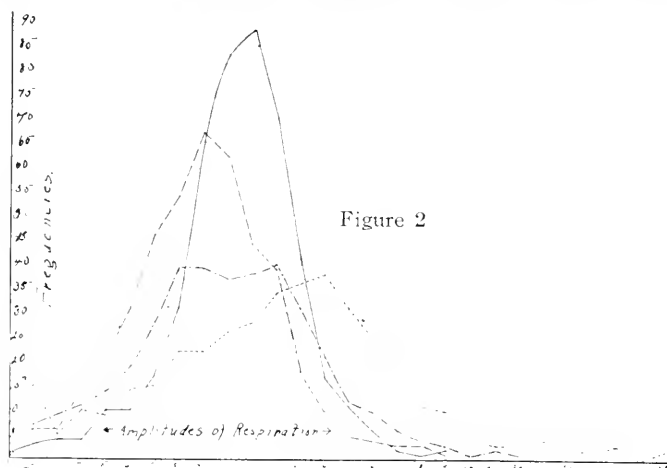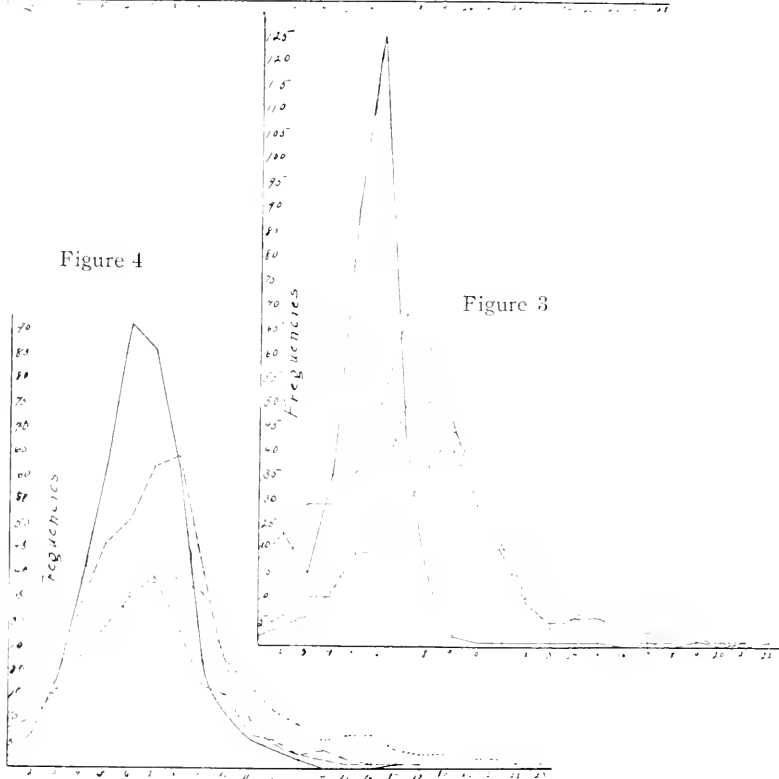
Figure 2

Figure 4

Figure 3

Fig. 2.   Curves showing respiration in the four cows while feeding: ——Seven H;
          — — — Three H; — — — - Two H; - - - - Five H.   (All figures are drawn
          to the same scale.)
Fig. 3.   Curves showing respiration in the four cows after feeding.
Fig. 4.   (Below).   Curves showing respiration in four cows before feeding.
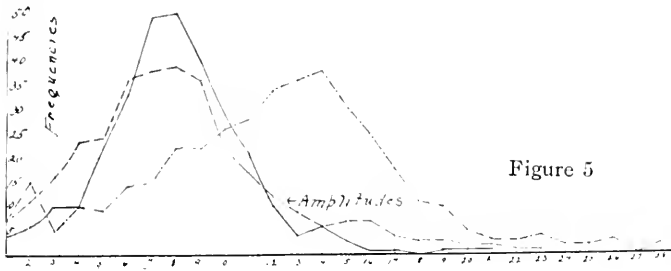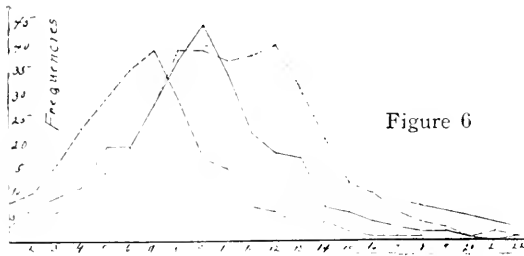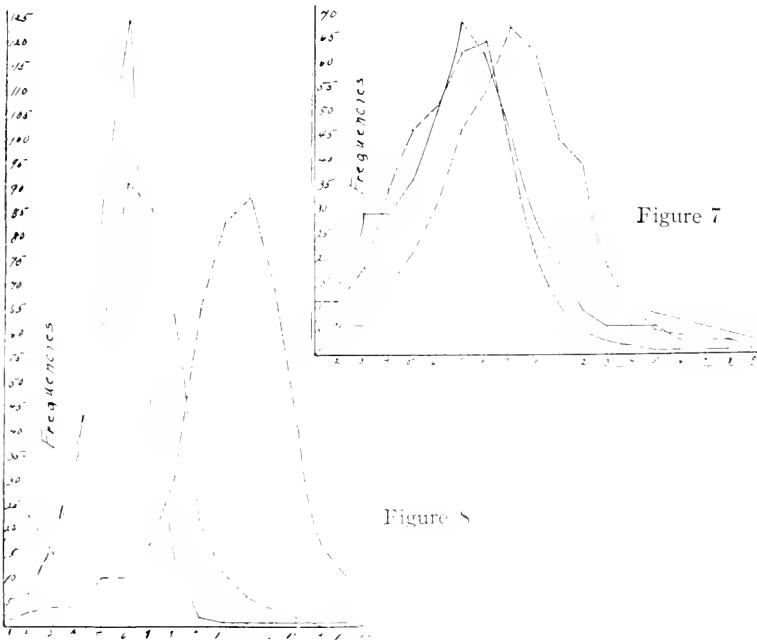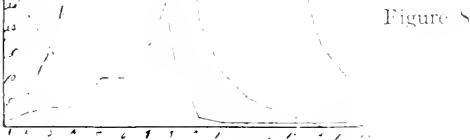
Fig. 5.   Respiration curves of cow Five H under three conditions: – – – – before
          feeding; – – – feeding, and ———— after feeding.
Fig. 6.   Respiration curves of cow Two H, under the three conditions.
Fig. 7.   Respiration curves of cow Three H, under the three conditions.
Fig. 8.   Respiration curves of cow Seven H, under the three conditions.

the results. A further explanation of this will be given later, as the specific cases come up for discussion. Finally, the appearance of the composites themselves are clearly indicative of the nervous reaction or "temperament of the animal.

The variations within each individual are beautifully illustrated by the polygons themselves. Beginning with Seven H, (Fig. 8), it will be seen that a marked difference is shown between the feeding condition as compared with those of before and after feeding. The composite of the former lies considerably to the right of the other two, which explains the fact that the mean has increased from 6.41 in the before feeding condition to 10.42 in the feeding condition, or the length of respirations increased, which indicates that feeding acted as a stimulus to the animal. Comparing the standard deviations, it will be seen that the feeding condition is the more variable. The composite of after feeding is the most uniform, the mean having gone down to 5.34 and the standard deviation to 2.20, the latter figure is perhaps a little high because of a few respirations of extreme length. The results indicate that during feeding, increased nervous activity or nervous reaction accompanied the feeding stimulus, and that before and after feeding the animal was more quiet and not so nervous.

The composite of Three H, (Fig. 7), shows the same results, but not as marked as with Seven H. The mean increased during feeding, but the standard deviation remained nearly the same as in the before feeding condition, while after feeding it increased slightly as compared to the other two conditions. The stimulus of feeding upon this animal did not show as marked effects as upon Seven H, merely increasing the mean or amplitudes of respiration, and so moving the polygon a little to the right. Not much difference is displayed between the before and after feeding conditions, both in appearance of the composites and their respective means and standard deviations. As a whole all three composites are very similar, which leaves the impression that Three H, is not easily disturbed and that her nervous make-up is of a stolid nature.

In the case of subject Two H, (Fig. 6), a more evident result is evinced, namely, that the animal has a marked tendency to be less active before feeding than after, which was not so marked in Seven H and Three H. The mean 6.73, and the standard deviation 3.09, in before feeding increased to 9.09 and

3.45 respectively in the after feeding condition. The condition of feeding also showed an increase of the mean, 9.97, and the standard deviation, 3.79, showing a marked reaction to the stimulus of feeding, more so than was shown in Three H and very nearly as great as in Seven H. Consequently, the nervous activity of Two H increased during feeding.

Finally, studying the composite of Five H, (Fig. 5), we see that a very nervous animal is indicated, which is readily shown by the conformation of the three polygons. Many variations exist and the polygons appear irregular and straggling. Here again the feeding stimulus shows its effect in increasing the nervous activity of the animal. The mean and standard deviation, (8.22 and 4.15), in the before feeding condition, increased to 11.97 and 5.16 respectively, in the feeding condition. Comparing the before and after feeding conditions, the mean 8.22 and standard deviation 4.15 in the before feeding condition decreased to 7.92 and 3.09 in the after feeding condition, instead of increasing as was shown in the former subjects. This may seem contradictory, but may be explained by the fact that the pneumographic tracings of Five H in the after feeding condition were taken too far away from the regular feeding time. Consequently, the mean decreased instead of increased. Had the after feeding condition been recorded nearer the feeding condition, the mean probably would have increased, and so established a like condition as in the first three animals. Taking the after feeding record farther away from the regular feeding time, up to a certain point, the nervous activity decreased, and with it the mean, as has been before explained. Because of the time element then the after feeding condition in this case would tend to indicate less nervous activity than in the before feeding condition.

In this connection an interesting fact might be brought out regarding all the subjects studied. Looking at all the polygons of the feeding condition, it will be noted they extend to the right of the others and are wider and flatter. Then in the after feeding condition the polygons move toward the left and become higher and narrower. And in the before feeding condition the polygons are a little to the right of the after feeding condition and slightly wider and flatter than in the after feeding condition, with the exception of Two H, where the before feeding tracings were taken farther from

the regular feeding time.   Owing to inconveniences in obtaining the subjects at definite times of the day, it was impossible to work with them at stated intervals before and after feeding. But had the penumographic curves been taken at definite times and alike for each subject, the above fact would probably have been illustrated more clearly, and would have shown that each individual possessed a cycle of nervous activity, being greatest at feeding, diminishing after feeding and continuing to diminish until the before feeding condition was reached, and then gradually increasing in nervous activity again until the feeding condition had been reached, when it would be at its height, and then this cycle would be repeated as the next feeding time approached.   Each animal of course would have a definite point, which would be characteristic of that individual, at which point the nervous activity would begin to increase or decrease, depending on the nervous make-up of the animal in question.   The times at which these tracings were made are different, but the attempt was made to choose approximately, a definite time, in so far as existing conditions would permit.

A general comparison of all the composite polygons mentioned may also be made.   It will be seen that each individual has its own characteristic polygon, and that each is distinctly different from that of any other.   Those of Seven H appear rather long and narrow.   (It will be noted that all the polygons are plotted to the same scale.)   Those of Three H are shorter and broader and more irregular, while the polygons of Two H are still shorter and broader and rather flat, with about the same amount of irregularities as those of Three H.   Lastly, those of Five H are the most irregular of the four and do not show much symmetry, but are spread over the entire width of the page.   Thus each animal shows its individuality in its respiration polygons, even under three different conditions, and the peculiar conformations and variations are distinctly characteristic of this one individual and not of any of the others. All of the composites seem to possess a common feature, namely: the shorter amplitudes show a higher frequency than those of extreme length; in other words, the long respirations do not occur as often as the short ones, which gives the polygons an abrupt slope to the left and a more gradual slope toward the right.

Variations Within the Group.—In making comparisons of variations within the group of animals studied, the composites of all the animals under a given condition were plotted on one sheet, thus facilitating the interpretation of results and making the comparisons more vivid. The following pages then represent the four animals under the same condition, i. e., before during and after feeding. Studying the polygons of the before feeding condition, (Fig. 4), it will be seen that each individual is represented by a distinct composite different from the others. The general conformation and appearance of each would lead to the conclusion that Seven H is the most quiet and Five H the most nervous, and Three H more nervous than Seven H and less so than Two H. In the order of their nervous activity then, they follow, Five H, Two H, Three H, and Seven H, as is indicated by the height, symmetry and narrowness of each polygon. This interpretation based on observation is entirely in accordance with the actual results. The mean and standard deviation of Seven H is 6.41 and 2.02 respectively, which increase to 6.69 and 2.57 in Three H, to 6.73 and 3.09 in Two H, and to 8.22 and 4.15 in Five H. A curious fact is here brought out that the coefficients of variability indicate the same order. They follow, Seven H, 31.59, Three H, 38.36, Two H, 46.02, and Five H, 50.49. This is because of the fact that the means and standard deviations do not increase in the same ratio, and the reason they do not increase in the same ratio, no doubt is due to the fact that the before feeding tracings of all the subjects were taken very nearly at the same time before the regular feeding time. (See above.)

Turning to the polygons of the feeding condition, (Fig. 2), the interesting fact heretofore mentioned is made more striking, that the stimulus of feeding increases the nervous activity of the animal. Comparing the shape of the polygons, the same order of nervous activity is seen, namely—Five H, Two H, Three H and Seven H. The same result is verified by the respective means and standard deviations of the respective animals. Here again the coefficients of variability read directly and conform to the order of nervous activity given above — beginning with 24.76 in Seven H and increasing to 43.12. It will be noted that the coefficients of variability in the before feeding conditions (Fig. 4), are as a whole relatively higher

than those in the feeding condition. This fact might be explained in that the means of the feeding condition are in turn greater than those of the before feeding condition, and as a result lower the coefficients of variability in the feeding condition. The pneumographic tracings of the feeding condition were taken under fairly uniform conditions, because here the time element was practically the same, since the tracings were made at the regular feeding time. Therefore these results are very significant and indicative of the degree of nervous activity or reactiveness of the four animals.

Lastly, taking up the after feeding polygons, (Fig. 3), we see the results are somewhat different from those previously studied. Taking into consideration the conformation and appearance of the composites, the curves of Seven H indicate the least nervous condition and next Three H, and Five H appears less active than Two H. Turning to the actual results of the means and standard deviations, the explanation for the difference will be found. Seven H has a mean and standard deviation of 5.34 and 2.20, which are increased to 7.21 and 3.04 in Three H and to 9.09 and 3.45 in Two H, while in Five H the mean and standard deviation decrease to 7.92 and 3.09 as compared to Two H. This may be due again to the same time element, which was explained above, when all the polygons of Five H were discussed. It is again brought out that the tracings of the after feeding condition of this animal, were taken too far from the regular feeding time, and so decreased the mean and standard of deviation. While the coefficients of variability of the before feeding and feeding conditions were in accordance with the order of nervous activities of the animals, in the after feeding condition they are not. They follow, Seven H, 41.20; Three H, 42.19; Two H, 38.02, and Five H, 39.08. Now here again the time of taking the pneumographic tracings causes this result. The after feeding polygons were taken in the morning, following the morning feeding, but they were taken at various times and not at a stated interval after feeding. This probably caused a variation of results because of the changing nervous activities of the animals, as the after feeding condition approached or withdrew from the feeding time.

DISCUSSION AND CONCLUSIONS.

The purpose of this study was primarily to try to establish a method whereby the nervous activity of cattle, or so-called "dairy temperament," might be measured. The results as given would indicate that by means of the pneumographic tracings the various nervous activities of cattle can be measured and placed upon a quantitative basis. Under the three conditions mentioned, the results point to the conclusions that animal Five H was the most nervous, next Two H, then Three H, and Seven H the least nervous. All the subjects reacted similarly, differing only in the degree of intensity of nervous reaction. And from the degree of intensity of nervous reaction arose the conclusions as to which animal was the more nervous.

Throughout the discussion, the term "temperament" and "dairy temperament" have been avoided as much as possible, and the term nervous acitivity used instead. Nervous activity or reactiveness as shown by these results, is the response to every-day stimuli through external and internal sensory connections with the respiratory center. As has been mentioned in the introduction, temperament, by definition is a mental condition or development. Now "dairy temperament," today is usually defined as a "predisposing tendency to convert food into milk." We are not satisfied that this definition has any quantitative basis. It is simply a deduction made from a combination of physical characteristics. Our work takes no cognizance of physical characteristics or outward indications, it deals only with the actual reactiveness of the animal. Physical characteristics as applied to "dairy temperament" have not been standardized, since they mean different things to different men, and what one man may call a prominent eye, another may not consider as such. It would be better then to speak of desirable physical characteristics, as dairy form, etc., alone, and not involve them with "dairy temperament." Instead of using this latter term, it might be better to speak of the degree of nervous activity or reactiveness which an animal possess.

Whether this study, if continued, will produce results of importance remains to be seen, but it is to be hoped that an interest in this special line of experimentation may be developed that will pave the way for further investigation. The conclu-

sions drawn at best, can be but tentative, since but few animals were studied.   To come to definite conclusions further study is necessary with more data.   Only when several hundred animals have been investigated, can the real value of this method be determined.   We would suggest that provisional measures of "temperament" may be obtained from the standard deviations of frequency polygons taken from several animals which are studied at the same time under the same conditions (preferably while feeding).   Correlations between the "temperament" or reactiveness of animals and their milk producing abilities would, it seems to us, yield definite information as to the value to be placed on the "temperament" or reactiveness of dairy animals.

BIBLIOGRAPHY.

1. **David Low**—Domesticated Animals of the British Isles.   MDCCLIII, p.-cvi.
2. **E. L. and J. N. Sturtevant**—The Dairy Cow, 1875, p. 85-92.
3. **Guenon on Milch Cows**—Orange Judd Co., 1888.
4. **Ripley and Dance**—Am. Cyc. D. Appleton Co., N. Y., 1876, Vol. XII.
5. **Henry Davis**—Philosophical Review, 1898, Vol. VII, pp. 162-180.
6. **Hoard's Dairyman**—1907-1908, Vol. 38, p. 1038.

	1912	Vol. 43, p. 588.
	1904	Vol. 34, p. 85.
	1905	Vol. 35, p. 1098.
		Vol. 28, p. 776; p. 391; p. 690.
	1915	Vol. 50, Nov. 5 issue.
	1916	Vol. 51, March 24 issue.

7. **Wisconsin Farmer's Institute Bulletin**—1887, Vol. 1, p. 194; 1888, Vol. II, p. 175.
8. **Sir John Lubbock**—On the Senses, Instincts and Intelligence of Animals. Int. Sci. Series, Vol. LXIV.
9. **Wesley Mills**—The Nature and Development of Animal Intelligence. 1898, McMillan Co., N. Y.
10. **Oscar Pfungst**—Trs. by Carl L. Rahn; Clever Hans, 1911. Henry Holt & Co., New York.
11. **Chas. Darwin**—The Expression of the Emotions in Man and Animals, 1905. D. Appleton Co., N. Y.
12. **Wm. Wundt**—Philosophiche Studien. Vol. 18, pp. 1-16.
13. **C. Lloyd Morgan**—Introduction to Comparative Psychology. 1894. Chas. Scribner & Sons, New York.
14. **C. Lloyd Morgan**—Can Animals Reason? The Spectator. Vol. 68, p. 683.
15. **I. P. Pavlov**—The Scientific Investigations of the Psychical Faculties or Processes in the Higher Animals. Science N. S., Vol. 24, p. 613.
16. **Mind.**—Vol. XVI, p. 262.

THE RELATIVE INTENSITY OF THE HARMONICS OF A LECHER SYSTEM. (EXPERIMENTAL).

By F. C. BLAKE and B. H. JACKSON.

In their fourth paper* on the free vibrations of a Lecher system, Blake and Sheard have shown how the tone intensity depends very much upon the edge-on distance between the plates, but they were unable on account of oscillator deterioration among other things to summarize this relation. We have made a careful study of the various factors that help to determine the tone intensity and present the results of our study in this paper.

I. APPARATUS.

The apparatus used was that employed by Blake and Sheard except that the brass plates used were 1 mm. thick instead of 4.5 mm. It is shown diagrammatically in Figure 1, where the letters are the same as in Figure 1 of Blake and Sheard's paper IV. This necessitated making eight small holes in pairs through the plates around the circumference through which the strings were passed and knotted. The diameter of each hole was about 0.6 mm. while that of the plates was 5.0 cm. The total area of the holes was thus about 0.4 per cent of the area of the plate,

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* Physical Review, N. S., IX, p. 177, 1917.

hence the effect of these holes could be entirely neglected, particularly since the coupling was always very loose, viz., 11 cm. On account of the tension of the strings and the thinness of the plates, the plates were slightly bowed, that is convex toward each other.   This effect was never greater than 8 parts in 1100, hence could be neglected.
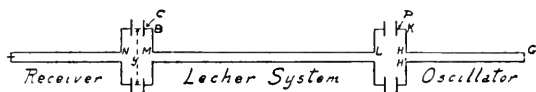

Figure 1.

II.   VARIABLE FACTORS.

The   following   variable   factors   required   study.   First, position of the bridge for each tone; second, influence of the spark-gap length; third, length of the oscillator; fourth, edge-on distance, y, between the plates; fifth, change of coupling, that is, change of the face-on distance, x, between plates; sixth, oscillator deterioration, that is, irregularity due to deposit of soot upon the metal rods of the spark-gap in oil; seventh, possible change in the sensitivity of the thermocouple even though soldered. While any one variable was being investigated, if another variable suffered a change it constituted a source of error for the time being.

Since the tension on the three circuits, oscillator, Lecher and receiver circuits, was kept always uniform, small variations of the lengths of the circuits could either be neglected or taken into account as needed.   Again as heretofore the receiver circuit was always just half of the Lecher circuit.   The fifth variable above, x, has been studied, but its importance demands a special paper.

Our method of handling the first two variables was as follows: With a given x and y, and a given oscillator length, having set the spark-gap at about the position for maximum intensity for a given tone, a bridge curve was taken across a given peak forward and backward.   Then the bridge being placed at the peak of a curve, a spark-gap curve was taken.   Without stopping to plot the observations at the time, the correct position of the bridge could be readily told to well within 0.5 mm. by mere inspection of the observations.

A sample of such curves is shown in Figure 2. For the bridge at 150 the lower of the two curves of Figure 2 was taken, then a bridge curve was taken and the reading of the maximum, viz., 100, was so far above the maximum of Figure 2 (lower curve) viz., 66, that another spark-gap curve was taken, the upper curve of Figure 2. These two curves illustrate very clearly and forcibly the meaning of oscillator deterioration. Evidently with so narrow a gap, viz., 0.00016 inch, it is easy for carbon soot from the decomposed oil to bridge, partially or wholly, the gap and thus decrease the intensity materially.
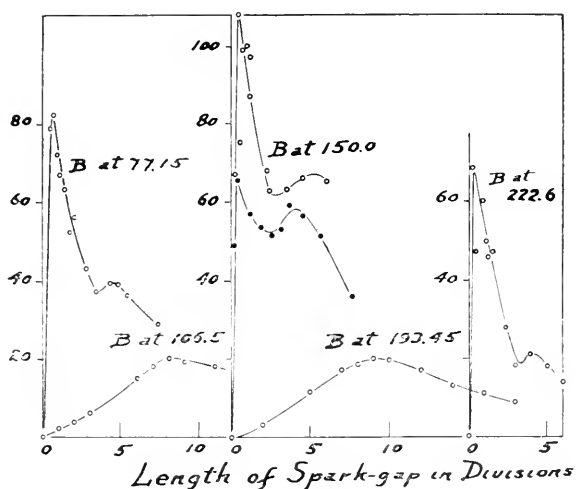
Figure 2.

The matter would be easy to handle if the gap were occasionally wholly bridged in this way, for observations under such conditions could easily be detected, and hence eliminated. If, however, in spite of the fact that we used only filtered oil the gap was only partially bridged by the carbon soot there does not appear any easy way to correct for this. When for the sake of inspection the oscillator rods were removed, the ends that constituted the spark-gap would be covered in places with dark spots, due to extremely fine soot being deposited in an extremely thin layer. This matter of oscillator deterioration would not be serious provided one could always employ a check receiver to advantage. This was indeed done in a considerable part of the work here reported. But we shall show later on in this paper that the profitable use of a check receiver is very limited.

Figure 3.

Neglecting momentarily the influence of oscillator deterioration, the only way in which the third and fourth variables could be studied was to get for every new length of oscillator both bridge and spark-gap curves for every peak; all this for a given y. And then for a new value of y we had to repeat all the above operations. 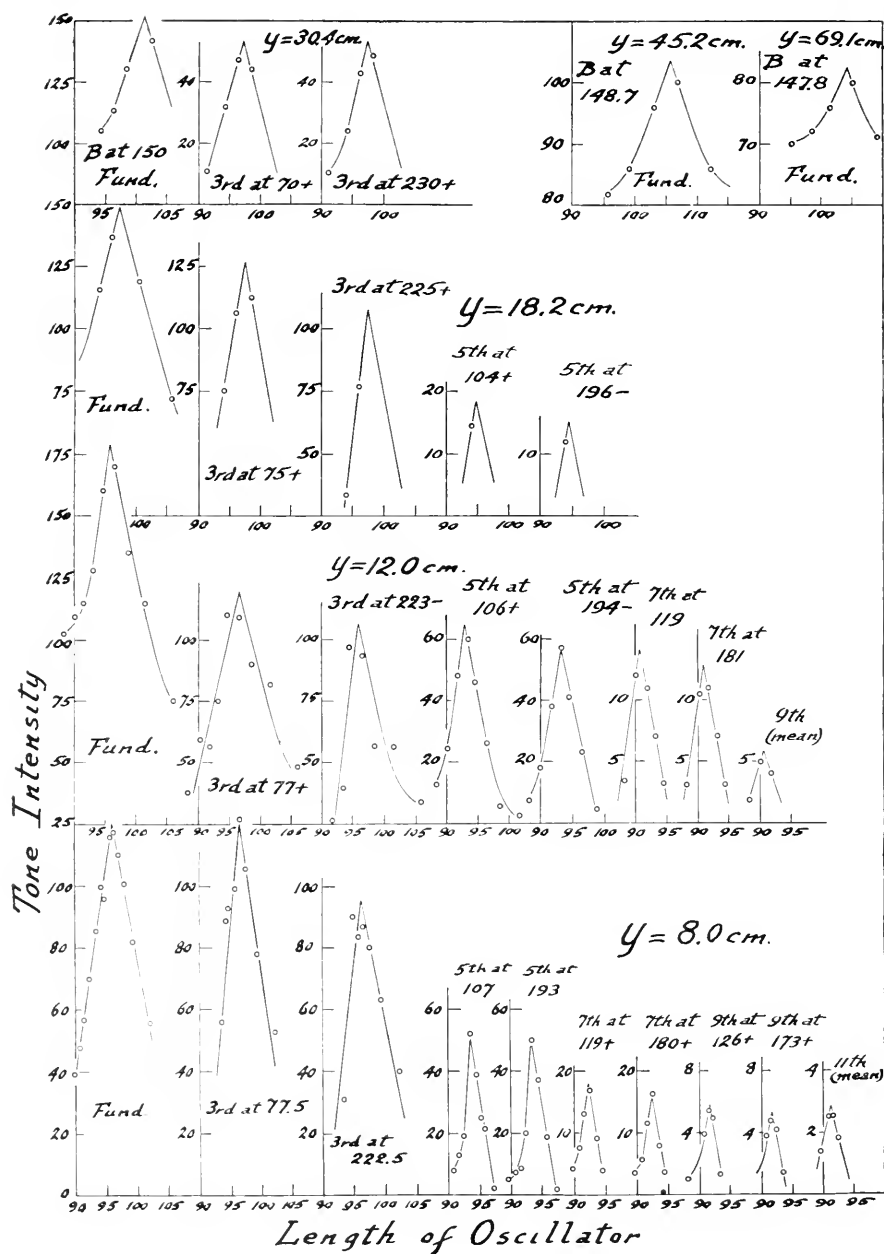Table I shows the various values of y used. It also shows the longest and shortest oscillator lengths, the length of the Lecher wires and of the receiver. As heretofore these lengths are the straight-away lengths, GH, LM, NT, Figure I.

III. SUMMARY CURVES AND TABLES FOR VARIABLE y.

Proceeding in the manner indicated above and plotting all bridge and spark-gap curves we obtained summarizing curves of intensity such as we have shown in Figure 3. They were obtained by tabulating the peaks of the spark-gap curves for different oscillator lengths.

It is plain from an inspection of Figure 3 that the higher tones are proportionately greater the smaller the y is, a thing Blake and Sheard found. For the curves for the values of y shown in the figure up to and including 30.4 cm., the fundamental was taken with the bridge at 150. But for values of y greater than 15 cm. the fundamental splits up into two peaks as the curves of Figure 4 clearly show (see also Curve II, Figure 5). Consequently in Figure 3 for $y = 18.2$ cm. and 30.4 cm., the relative intensity of the fundamental is too low. A further study of Figure 3 shows also that as y increases the length of oscillator for maximum resonance increases. Our results on this matter are summarized in Curves III, Figure 5. For harmonics above the third the intensity is so low for the larger values of y that one is not able to examine how the optimum oscillator length varies. For the fifths the optimum oscillator length for $y = 18$ is unquestionably somewhat longer than for $y = 12$, but the variation is proportionately less than for the thirds and fundamental.

IV. Various Corrections.

The sets of curves for Figure 3 for different values of y cannot be directly compared with one another for several reasons. First, those of $y = 8$ cm. (together with the fourth and sixth sets shown in Table I) were taken with a different thermo-couple from the rest. Second, the different sets were taken often several days apart and the oscillator deterioration as well as possible change in sensitivity of the thermocouple needed to be eliminated or corrected for. Third, the change in room temperature, while not great, undoubtedly affected the dielectric constant of the olive oil used in the spark-gap and consequently the energy as read at the receiver.
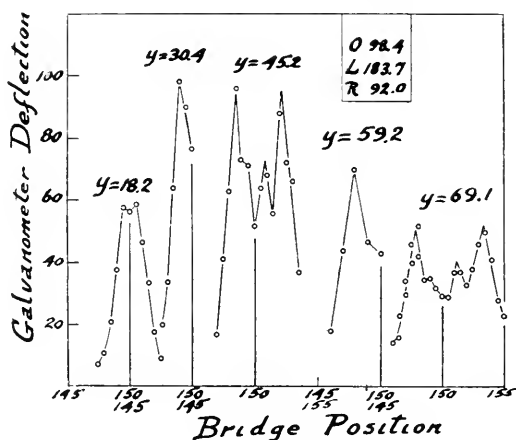
Figure 4.

In the light of our experiments there seems to be a distinct deterioration in the sensitivity of our thermocouple even though soldered. For with a polished spark-gap and other conditions the same the intensity was often distinctly less for all the tones of a set for a given y than when the same set was taken earlier. Any figures we could give in illustration of this fact would not be worth much, for manifestly the other factors, such as oscillator deterioration and temperature change, are not readily differentiated from the sensitivity changes of the thermocouple. The fact that these three factors cannot be readily differentiated one from another shows, too, the futility, for the object we had in mind, of employing a check receiver. Moreover, while

for the bridge curves the check receiver helped to eliminate oscillator variation, it proved wholly useless for spark-gap curves. The check receiver was placed, after Blake and Sheard, near the oscillator spark-gap, but in general the maximum for the two receivers did not occur at nearly the same spark-gap length, hence neither curve could be used to correct the other except by an approximation method of some sort. Hence we abandoned its further use. Accordingly, the only safe way to make a direct comparison of the curves of Figure 3 was to get some one tone, say the fundamental, to a common basis.
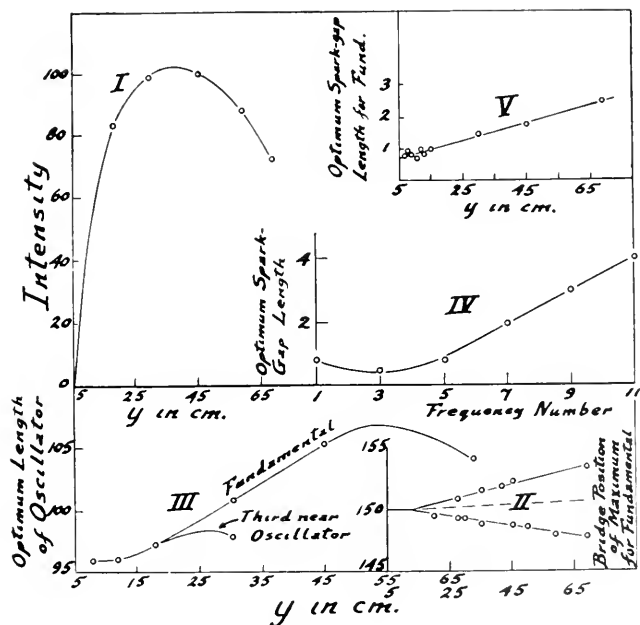
Figure 5.

Before describing the manner of reducing our corrections to a common basis it is well to point out first, however, that the optimum spark-gap length varies with the frequency-number just as Blake and Sheard found (see their Figure 12). Curve IV of Figure 5 summarizes roughly this relation as the mean value for all the y's used. The optimum spark-gap length for a given tone is not independent of y, however, as Curve V of that figure shows for the fundamental. It is clear from Curve IV, that the optimum spark-gap length decreases with

the frequency numbers in general, reaches a minimum for the
third harmonic, and rises again for the fundamental.   Curve
V shows that the optimum spark-gap length for the funda-
mental increases with increasing y in a linear ratio.   This is
probably true for the higher tones also, though the variation
is so little outside of the limits of experimental error that it
would be difficult to show this for the higher tones.   Curves
IV and V show the absolute need for taking spark-gap curves if
the tone intensities are to be compared.
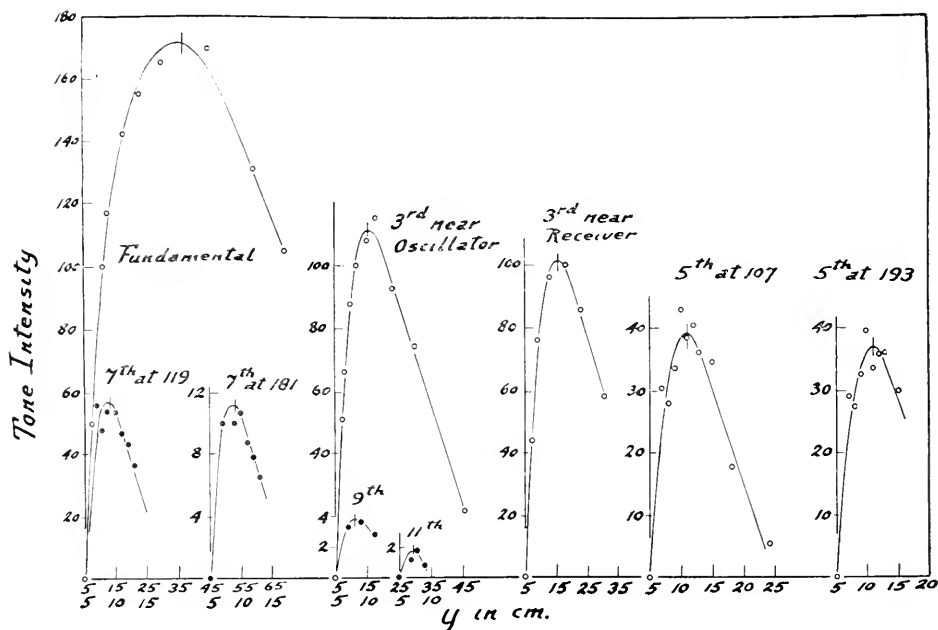
Figure 6.

To eliminate the various curves discussed above and to get
at a common basis for comparison of the various sets of curves
for the different values of y we proceeded as follows.   Starting
with a given oscillator length GH, and a given total length GT
of the system, Figure 1, the value of y was changed from large
to small values by steps in as short a time as possible.   For
each y we located the fundamental peak or peaks and then took
spark-gap curves.   In this way Curve I of Figure 5 was obtained.
The curve is extrapolated to zero for $y = 5$ cm., for at this distance

the inner edges of the plates would touch. We then reduced all the summarizing sets of Figure 3, together with all the other sets not shown, to correspond to the standard for the fundamental for $y = 18.2$, viz., 142 (see Figure 3). In this way the curves of Figure 6 were obtained. They certainly cannot be much in error.

The curves for the ninth and eleventh harmonics represent an average set of values since not every peak was investigated for those tones for every change of oscillator. The other curves of Figure 6 give the fundamental and the thirds, fifths and sevenths on both sides of the fundamental. By taking the average of the two thirds, the two fifths and the two sevenths, the damping is eliminated and the results can be compared directly with the fundamental.

V. The Question of Damping.

Before making the comparison it is well to ask two questions. How is the intensity of a peak affected by the fact that it is split in two? Is the damping sufficiently small that by taking the arithmetical mean of any two corresponding tones equally distant from the fundamental it can be eliminated? We proceed to the answers to these questions.

For the results shown in this paper the coupling, x, was kept constant at 11 cm. But we have shown before that for $x = 8$ cm. and less and for small values of y the fundamental is split up. Evidently, then, an increase of y acts like a decrease of x; it causes two periods for a given tone. In our arrangement we detect these two possible periods (or wave lengths) by means of a sliding bridge. Manifestly, when one period is present, the other is absent, so far as the receiver is concerned. In other words, *all* of the energy is in *each* of the two peaks of the fundamental.

The second question, it would seem, can be answered in this way. The fact that the peak on the oscillator side of the fundamental is higher than the corresponding peak on the receiver side of the fundamental makes it plausible to say that if I_o is the intensity at the oscillator spark-gap say and I the intensity at some point along the system the equation $I = I_o e^{-ax}$ would hold where a is the logarithmic decrement.

Whence for two different distances x_1 and x_2 we can say $I_1 = I_o e^{-ax_1}$ and $I_2 = I_o e^{-ax_2}$ whence

$$\alpha = \frac{\log_e \; I_1 \; I_2}{x_2 - x_1}$$

Now for the third harmonic $x_2 = \dfrac{4\lambda_3}{2}$ and $x_1 = \dfrac{2\lambda_3}{2}$ whence $x_2 - x_1 = \lambda_3$. Similarly for the fifths and sevenths $x_2 - x_1$ would equal λ_5 and λ_7 respectively. The ratio $\dfrac{I_1}{I_2}$ for the thirds is $\dfrac{111}{101} = 1.099$. For the fifths and sevenths this ratio is $\dfrac{38.5}{36.9} = 1.044$ and $\dfrac{11.4}{11.2} = 1.017$ respectively.

Using the figures for λ_s given for $y = 8$ cm. viz., $\lambda_3 = 145$, $\lambda_5 = 86$, $\lambda_7 = 61$, we get α to be 0.00065, 0.00050, 0.00028 respectively. Thus the value of α apparently decreases for the higher harmonics. It may fairly be questioned, however, whether the question of damping can be treated as simply as here given. Using the values of λ_s corresponding to the *optimum* values of y, which we shall call y_s, viz., $\lambda_3 = 150$, $\lambda_5 = 87$ and $\lambda_7 = 61$, changes the values of α but little. Now Blake and Sheard* have shown that the electrostatic leakage, which they called "θ (y)" was greater for the lower tones than for the higher tones. This would readily explain the larger values of α for the lower tones.

The important thing at present, however, is that in any case the value of α must be very small. Even though we measured x, not from the oscillator spark-gap, but from the Lecher plates, the value of α would be doubled only. There seems no good justification for doing this, however.

For the third harmonic, using the value of α first given, 0.00065, and calculating the intensity I of the third at the middle of the Lecher system we get $I = 105.9$. The arithmetic mean of 111 and 101 is 106.0. This is the justification for taking the arithmetic mean of the two tones either side of the fundamental to get the tone intensity of any tone that can fairly be compared with the fundamental. The question of damping is thereby eliminated.

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* Physical Review, l. c.

It seems very likely that the question of damping can be handled thus simply for the cases here considered. Blake and Sheard have shown that we are dealing here, when the coupling is loose ($x = 11$ cm. is a very loose coupling), with the free vibrations strictly and since our system is a strictly non-radiant system the damping must be very small. It is perhaps an open question whether the logarithmic decrement thus measured was the decrement of the receiver merely or of the total oscillating system. Likely the former, however, since the oscillator and the distance y was purposely changed so as to have the energy at the receiver the maximum possible for each tone, with a given constant input of energy at the oscillator spark-gap.

VI.   Relation Between Tone-Intensity and Edge-on Distance.

Thus the energy at the receiver is distributed among the various tones as follows, the figures being read off directly from the curves of Figure 6: fundamental 172, third 106, fifth 37.7, seventh 11.3, ninth 3.8, eleventh 1.8. Expressed in per cent. the figures run 100%, 61.63%, 21.92%, 6.57%, 2.21%, 1.05%. With the more complete data given in this paper we have thus been able to determine quantitatively the influence of the edge-on distance between plates upon the tone-intensity. Blake and Sheard were able to give a qualitative answer only.

If we plot the optimum distance between plates, y_s, against the frequency number, we get Curve III of Figure 9. With an average error of less than 1 per cent. and a maximum error of 1.7 per cent. this curve gives the empirical relation

$$N \text{ s } \log_e y_s = \text{Constant}.$$

We are not prepared at present to state whether such a relation has any important significance. Calculating the distances y_s required to fit the formula we get the following values: 36.8, 15.5, 11.1, 9.15, 8.00, 7.25. In the curves of Figure 6 the short lines parallel to the y axis cutting across the curves are shown at these points. Manifestly, within the limits of error, they cut at the top of each maximum.

TABLE I.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ν cm.	Lecher Wires cm.	Receiver cm.	Oscillator cm.	s 1	MEAN BRIDGE POSITION, l's 3	5	7	9	11	MEAN WAVE LENGTH, λ's s-1	3	5	7	9	11	p	S/s experimental	l's experimental	κ₀/κ exp'm't'l	S/s theoretical	l's theoretical	κ₀/κ theoretical	% Error in κ₀/κ	% Error in λ's
7.15	180.50	90.2	105.7 to 90.1	150.00	77.05	63.88	89.54	80.53	(94.60)	442.90	115.81	(86.12) 86.00	60.44	46.34	37.40	246.32	442.90		14.60	442.90	96.32	11.60	0.00	0.00
					150.00	107.00	119.76	150.00	150.00	442.90	115.81	86.01	60.47	46.43	37.58		437.52		14.64	437.43	23.42		+0.27	+0.02
					222.89	150.00	150.00	219.51	206.10								430.00		14.58	430.05	10.32		−0.11	−0.01
						193.00	180.20										423.08		14.42	423.29	5.62		−1.23	−0.05
						236.12	210.43										417.06		13.71	417.87	3.46		−7.60	−0.24
																			11.61	413.38	2.37		−20.6	−0.48
8.0	179.95	89.9	102.2 to 88.2	150.00	77.50	107.08	119.75	126.71	131.05	440.07	115.04	85.82	60.42	46.16	37.67	246.47	440.07	96.47	13.70	440.07	96.47	13.70	0.00	0.00
					222.51	192.90	180.17	173.20	168.72	440.07	115.11	85.78	60.41	46.11	37.60		435.12	23.95	13.62	435.12	23.00		−0.58	−0.07
																	429.10	10.65	13.82	428.00	10.89		+0.88	+0.05
																	418.14	5.84	14.15	422.87	5.86		+0.44	+0.02
																	411.37	3.55	11.85	417.69	3.65		+3.28	+0.11
																		2.30		413.60	2.47		+8.40	+0.19
9.0	180.11	90.2	102.1 to 90.0	150.00	77.28	63.66 / 106.83	89.11 / 119.61	79.90 / 103.00	131.31	440.36	145.60	(86.12) 86.36	60.88	46.82	37.94	247.24	440.36	97.24	13.03	440.36	97.24	13.03	0.00	0.00
					222.88	193.19 / 236.50	180.50 / 210.91	173.35 / 196.75 / 220.36	169.25	440.36	145.48	86.13	60.71	46.70	37.85		436.80	24.11	13.15	436.31	23.50		+0.92	+0.08
																	431.90	10.88	13.56	430.65	11.11		+4.22	+0.27
																	426.16	5.92	13.84	424.97	6.18		+6.21	+0.25
																	421.38	3.60	14.21	420.30	3.84		+8.30	+0.26
																	417.34	2.39	14.48	416.35	2.62		+11.1	+0.24
10.0	179.40	89.7	100.0 to 86.4	150.00	77.65	167.00	119.57	126.50		436.38	144.65	86.10	60.87	47.00		247.15	436.38	97.15	12.06	436.38	97.15	12.55	−3.91	−0.53
					222.30	193.10	180.41	173.50		438.72	144.82	85.84	60.56	46.59			433.95	24.75	12.36	434.46	24.74		−1.51	−0.12
																	430.50	11.05	13.14	429.20	11.31		+4.70	+0.30
																	426.09	5.85	14.04	423.92	6.31		+11.9	+0.51
																	423.00	3.15	16.70	419.31	3.97		+33.0	+0.88
11.1	180.40	90.2	102.1 to 89.0	149.94	77.00	62.77 / 106.44	88.37 / 119.61	102.65 / 126.34		439.28	115.86	(87.19) 87.00	61.62	47.40		248.25	439.28	98.25	11.63	441.31	98.25	12.21	−4.98	−0.46
					222.86	193.11 / 237.15	180.75 / 211.62	173.70 / 197.41		441.31	116.04	86.60	61.14	47.05			437.58	25.32	12.08	438.12	25.23		−1.31	−0.12
																	435.00	11.35	13.12	433.00	11.65		+7.18	+0.46
																	431.34	5.82	14.54	427.98	6.54		+18.8	+0.78
																	426.60	3.45	15.33	423.45	4.15		+25.2	+0.74
12.0	179.20	89.5	106.3 to 88.3	150.08	77.51	62.73 / 106.72	119.10	126.17		434.75	145.14	(87.42) 87.00	61.95	47.98		248.10	434.75	98.10	10.67	439.63	98.10	12.00	−11.1	−1.12
					222.68	193.72 / 237.60	181.05	174.15		439.63	145.51	86.44	61.01	46.94			435.42	25.53	11.60	436.62	25.33		−3.33	−0.27
																	435.00	11.10	13.49	432.20	11.66		+12.4	+0.65
																	433.65	6.18	17.05	427.07	6.59		+42.1	+1.54
																	431.82	2.14	26.54	420.66	4.22		+121.2	+2.22
13.1	180.20	90.1	102.1 to 89.4	150.15	76.84	106.17	118.80			437.00	146.60	88.03	62.70			249.16	437.00	99.16	10.16			11.79		
					223.44	191.20	181.50										439.80	25.86	11.63					
																	440.15	11.13	13.76					
																	438.90	5.11	17.75					
15.1	180.10	90.0	100.6 to 89.1	150.12	76.47	105.71	118.50			439.50	73.65 / 74.27	44.41 / 44.66	31.62 / 31.63			250.11	439.50	100.11	9.81			11.50		
					224.39	194.78	181.75				147.92	89.07	63.25				443.76	27.15	10.45					
																	445.35	11.04	14.37					
																	442.75	4.71	17.56					
18.2	181.04	90.5	105.4 to 94.0	150.15	75.40	104.75				444.65	74.75 / 75.15	45.40 / 45.55				251.58	444.65	101.58	9.64			11.18		
					225.30	195.70					149.90	90.95					449.70	26.63	11.66					
																	454.75	10.63	16.03					
30.4	180.80	90.4	102.5 to 91.2	149.15 and 151.25	70.74						79.46 / 79.98					258.13	478.32	28.41	12.30			10.57		
					230.18						159.44													

VII.   How Does the Capacity of the Condensers Vary With the Edge-on Distance Between Plates and With the Plate Thickness?

Blake and Sheard found that for small values of y the value of κ_0/κ, that is, the end-capacity expressed in equivalent wire-length, was practically constant, as calculated from the data for the different harmonics.   This was to be expected on account of the small range of frequencies they worked with, viz., 1 to 9. The range in this paper is but slightly greater, viz., 1 to 11, hence we should expect to confirm their results in this regard. This is indeed the case as Table I clearly shows.   Columns 5 to 10 inclusive give the mean positions of all the peaks for all the tones.   The upper set of figures in columns 11 to 16 inclusive give the experimental values of λ_s, the wave-length corresponding to the frequency number, s.   In column 13 the figures in parentheses are the observed values of the wave-lengths of the fifths obtained by subtracting the two outer fifths from each

other and dividing by 2, e. g. $\dfrac{236.12-63.88}{2}=86.12$.   Blake and

Sheard observed that the outer internodal spaces for the fifths were distinctly larger than for the inner internodal spaces. Since they did not observe this for the sevenths and ninths within the limits of experimental error they attributed this to the presence of the small ebonite supports, R_1, R_2, R_3, R_4 in the immediate vicinity of these outer peaks for the fifths.   Our results confirm theirs.   In the calculations the outer fifths were not used.   We found, however, that the intensity of the outer fifth near the oscillator is not as great as that of either of the two inner fifths, whereas it should be somewhat greater.   This was true for all the values of y for which the outer fifths were measured.   Column 17 gives the position C, Figure 1, obtained by adding $3.5+\tfrac{1}{2}(y-2)$ to the plum-bob reading M as given on the 3-meter stick.   It is the reading of the back of the Lecher plates next to the receiver.   Column 19 is calculated in

the manner indicated in Blake and Sheard's paper (q. v.).*
Column 20 is obtained by means of the formula

$$\frac{\kappa_0}{\kappa} = \frac{\lambda_s / 2\pi}{\tan\left(\dfrac{l_s \lambda_s}{2\pi}\right)}$$

The first figure in each set in column 18 is obtained by extra-
polation as given in Figure 7, full lines, and Figure 8, where the
points plotted are the remaining figures in column 18. Naturally
there is some degree of latitude in making this extrapolation.
For instance, one could so change λ_1, in the sets mentioned
in the accompanying note, as to leave the first value in column
20 unchanged from the figure given in the table. We believe,
however, that the reader will agree from an inspection of the
curves of Figures 7 and 8 that the extrapolated values for λ_1
given in the table are not greatly in error.

Column 23 was obtained in the following way. The first
set of column 20 is a decreasing set, the second an increasing
set but in each case the first four figures are fairly constant.
Using the first four figures of each set and allowing for the slight
decrease and increase respectively the first two figures were
taken as given in column 23. With these two given, the remain-
ing figures in that column were obtained by graphical methods
by assuming that κ_0/κ varied with y according to the relation

$$\kappa_0 \propto \frac{1}{\log_e \dfrac{d+\sqrt{d^2-b^2}}{b}}$$

where d is equal to $\dfrac{y}{2}$ and b is the radius of the plates,

viz., 2.5 cm. Thus all the figures in column 23 except the
first two may be said to be extrapolated from them. Columns
21 and 22 are similar to columns 18 and 19 respect-

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* It is to be noted that in column 5 the fundamental maximum is not exactly
at 150.00. For values of y less than 12 cm. this is to be explained by slight
inequalities in the lengths of the wires, e. g., BM, HK, etc., leading to the plates
together with slight inequalities in the couplings at the four sets of plates. For
values of $y=15$ cm. say and above, at which the fundamental tends to split in two
the maximum is always at a length slightly greater than 150 as the dotted line of
Curve II, Figure 5 shows. In column 19 the value of l_s given for the fundamental
is given as if the peak were exactly at 150, i. e., $l=p$–150. If the value of the
position of the fundamental given in column 5 were used l_1 would be slightly dif-
ferent from the figure given for it in column 19, being in general slightly less than
such figure. This would tend to raise slightly the value of the first figure in column
20 for sets 3 and 6 to 10 inclusive and to lower it in set 5.

ively using the figures of column 23 instead of column 20. In column 21 the first figure in each of the first three sets is arbitrarily taken equal to the first figure in column 18, the first figure in column 22 being necessarily equal to that in column 19. The justification for this may be seen in Figure 7 where columns 18 and 21 are plotted against the frequency number for the first five sets, column 21 being represented by the dotted lines. For $y = 8$ the agree-
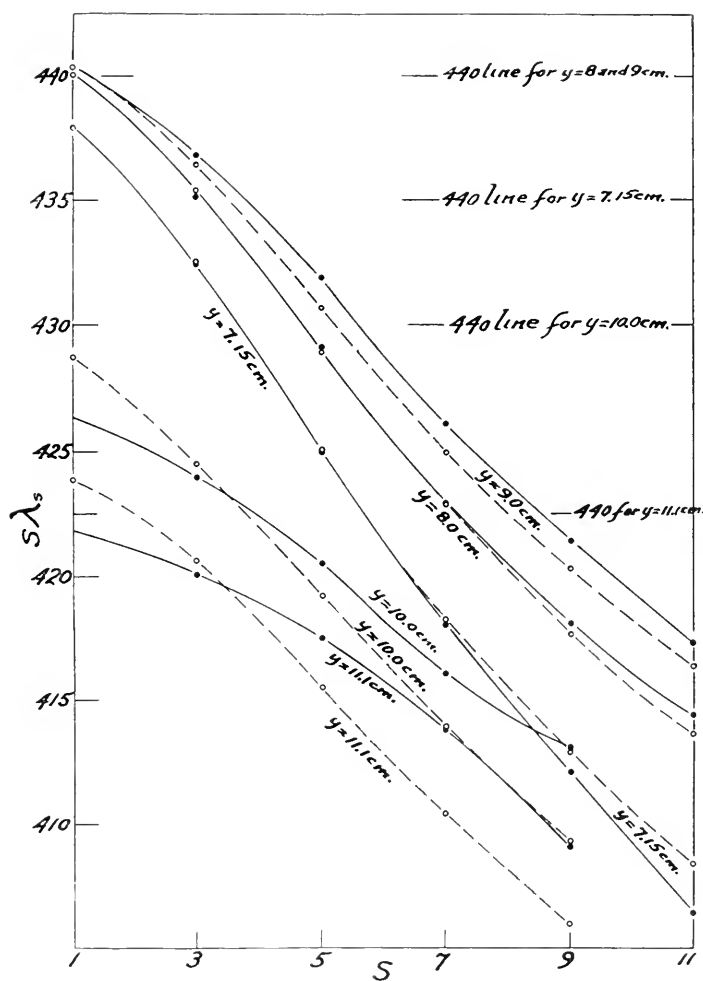
Figure 7.

ment between the two columns is seen to be very good and fairly good for $y = 7.15$, the variation being in the opposite direction.   For $y = 9$ the variation is greater and in the same direction as for $y = 8$ cm.   For $y = 10$ and 11 cm. it is plain that the theoretical and experimental curves can no longer be extrapolated to the same value.   Plainly the agreement gets worse as y increases, due to the lack of constancy in column 20 for a given set.   In column 24 is given the percent. of error in column 20 as against the value given in column 23.
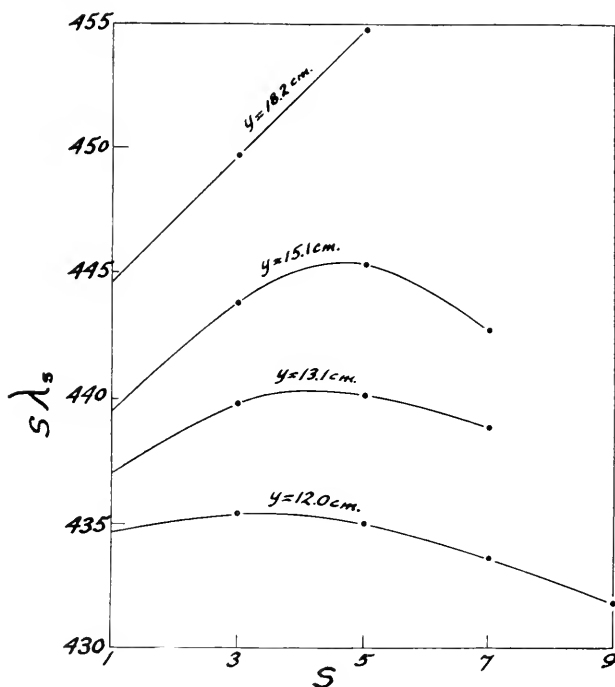
Figure 8.

The lower set of figures in columns 11 to 16 inclusive is obtained by calculating λ_s from the equation given above, using the values for κ_0, κ given in column 23.   Since the equation is transcendental the method of approximation has to be used. Multiplying this λ_s (theoretical) by 's' gives column 21.   Comparing the two sets of figures in columns 11 to 16 inclusive we get the per cents of error given in column 25.

Remembering that the thing that is experimentally deter-mined is λ_s the percents of error in column 25 are remarkably small. Averaging for all the sets we may say approximately that one per cent. variation in λ_s with its consequent variation in l_s according to the formula

$$l_s = p - \left\{ 150 + (s-a)\frac{\lambda_s}{2} \right\}$$

where s is the frequency number 1, 3, 5, 7, etc., and a the corresponding natural number 1, 2, 3, 4, etc., changes the value of κ_0 κ for values of $s = 1$, 3, 5, 7, 9, 11, respectively 8, 11, 15, 22, 32, 44 per cent. This serves again to emphasize the importance of an accurate measurement of λ_s.
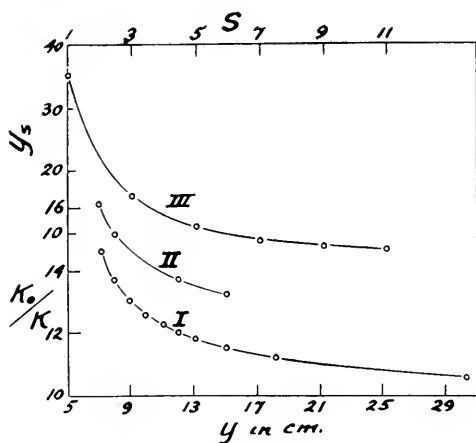
Figure 9.

We have gone into the method of these calculations with some detail because of the dependence placed upon the figures in the theoretical paper by one of us that follows this paper.

Two things stand out from this discussion of Table I. The value of κ_0 κ is very constant for small values of y; and a small error in the wave length determination makes a large error in the constancy of κ_0 κ, the errors being larger propor-tionately for the smaller wave-lengths. The first point was made by Blake and Sheard and we thus confirm it. For the first three sets of the table the average error in λ_s is only 0.13 per cent.

Blake and Sheard showed that the inconstancy of κ_o/κ for larger values of y was due to the effect of the phase changes introduced by the factor which they called "ϕ (y)" due to the fact that a portion of the wires was at right angles to their main lengths and perhaps to the fact that at points like B and K, Figure 1, there is a change of diameter of the wire where it enters the small rod to which the plate is attached. It is conceivable that the reflection coefficient at such points is not necessarily negligible for the higher harmonics whereas it might be for the lower tones. The greater y is the larger the phase changes for the higher harmonics in comparison with the lower harmonics. These phase changes act in the same direction as the phase change γ due to the end capacities, hence the apparent κ_o/κ would be larger for the higher tones.

If we plot the values of κ_o/κ given in column 23 against y we get Curve I of Figure 9. For the sake of comparison the values Blake and Sheard obtained for plates of the same diameter, but of thickness 4.5 mm. instead of 1 mm. are shown in Curve II. Thus, the extra capacity of the thicker plates for the coupling 11 cm. is about 10 per cent.

SUMMARY.

We have determined experimentally the relation between the tone intensity and the distance between the plates edge-on and have found the optimum distance y_s for a tone of a given frequency number s to fulfill the empirical relation $y_s = Ce^{-\sqrt[4]{s}}$ A theory to account for the tone-intensity as a function of the phase change γ and the wave-length λ is given in the next paper.

THE RELATIVE INTENSITY OF HARMONICS OF
A LECHER SYSTEM. (THEORETICAL).

By F. C. Blake.

In the previous paper Blake and Jackson have shown the dependence of tone-intensity upon the edge-on distance between plates. They have found that the optimum condition for each tone is such that, for a given in-put of energy at the oscillator, the energy is distributed among the various tones as follows, the fundamental being taken as 100%: third, 61.63%, fifth 21.92%, seventh 6.57%, ninth 2.21%, eleventh 1.05%. In this paper a theory is given to account for these results.
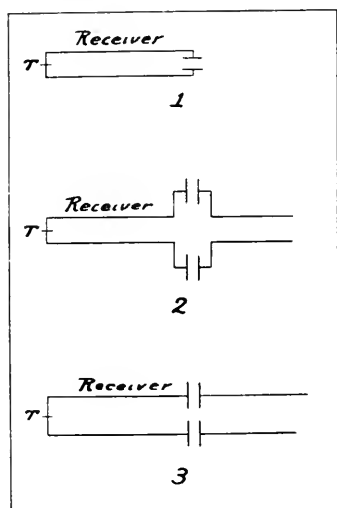
Figures 1, 2 and 3

The theory makes use of the Kirchhoff-Abraham generalization of Kelvin's formula for the discharge of a condenser. As given in Abraham's "Theorie der Elektrizität," Vol. II, 2nd edition, we consider electric waves coming from the negative X direction (Figure 1) along two parallel wires that end in a condenser. Our experimental arrangement was necessarily different from that, but if we fix our attention upon the receiver alone and remember that the optimum oscillator-length is different for each tone it is obvious that, so far as the total energy on the receiver is concerned, our arrangement (Figure 2) is identical with Figure 1.

Later in this paper we shall discuss the conditions under which the practical case, Figure 2, may be said to conform to the ideal case, Figure 3. For the moment we shall call them identical.

Abraham's expression for the potential difference, ϕ per unit length of the wires (Figure 1) is

$$\phi = \frac{2A}{\kappa} \cos\left(\frac{2\pi x}{\lambda} - \gamma\right) \cos 2\pi\, nt$$

where A is a constant, κ the capacity per unit length, λ the wave-length, γ the phase change due to the end-capacity and n the frequency. We consider the total energy on the receiver that surges through the thermo-couple as made up of two parts, that on the wires themselves and that on the condenser. Suppose at a certain moment the condenser plates are charged to a maximum value. Due to the distributed capacity of the wires there is also at that moment a charge on them. A moment later these charges discharge through the thermocouple thus recharging the plates and wires with electricity of the opposite sign. During the half period of the galvanometer, viz., 1.4 sec., millions of vibrations surge through the thermocouple. The galvanometer needle moves off until the loss of energy by heat conduction and radiation from the thermocouple equals the input of energy. The scale usually moves off in a very vigorous fashion showing that the losses of energy are not appreciable till near the end of the half period of the galvanometer. We shall assume the rate of loss of heat energy by radiation from the junction to be independent of the frequency of the tone surging through it, and that Newton's law of cooling holds with respect to the surroundings.

In order to calculate the energy that surges through the thermocouple we must get the root-mean-square value of the potential as it is distributed both as to space and time. If we substitute $\dfrac{x}{n\lambda}$ for t in the above expression we can say that the total energy on the wires is given by the expression

$$\frac{1}{2}CV^2 = \frac{1}{2}\kappa\left(\frac{s\lambda}{4} - \frac{\gamma\lambda}{2\pi}\right)\int_{-\frac{s\lambda}{4}+\frac{\gamma\lambda}{2\pi}}^{0}\left[\frac{2A}{\kappa}\cos\left(\frac{2\pi x}{\lambda} - \gamma\right)\cos\frac{2\pi x}{\lambda}\right]^2 dx$$

The distance from the thermocouple to the back of the receiver plates is $\dfrac{s\lambda}{4}-\dfrac{\gamma\lambda}{2\pi}$.

Hence the total capacity of the wires is $\kappa\left(\dfrac{s\lambda}{4}-\dfrac{\gamma\lambda}{2\pi}\right)$

The energy on the plates is represented by

$$\frac{1}{2}CV^2=\frac{1}{2}\kappa_0\left[\frac{2A}{\kappa}\quad\frac{\gamma\lambda}{2\pi}\cos\gamma\right]^2\frac{s}{2}.$$

The condenser is at the point $x=o$. In the above expression for ϕ put $x=o$ and we have $\phi=\dfrac{2A}{\kappa}\cos\gamma$ per unit length.

The equivalent wire-length of the condenser is $\dfrac{\gamma\lambda}{2\pi}$.

But the plates are not charged all the while, hence V^2 in the expression for the energy on the plates must be taken

$$V^2=\frac{4A^2}{\kappa^2}\frac{\gamma^2\lambda^2}{4\pi^2}\cos^2\gamma\cdot\frac{1}{\tau}\int\cos^2\nu\,t\,dt.$$

$$\text{Now }\frac{1}{\tau}\int_0^\tau\cos^2\nu\,t\,dt=\frac{1}{\nu\tau}\int_0^{2\pi}\cos^2 x\,dx=\frac{\pi}{\nu\tau}.$$

But the plates are charged n times a second, and since $\nu=2\pi n$ and $n\tau=1$, multiplication by n gives $\dfrac{n}{2}=\dfrac{n_0 s}{2}$

where $n_0=$ frequency of the fundamental tone and s the frequency number.

Integrating the above expression for the energy on the wires we get as the expression for the total energy E,

$$E=\frac{n_0A^2\lambda^2}{4\pi^2\kappa}\left[s\gamma^2\cos^2\gamma\frac{\kappa_0}{\kappa}+\frac{1}{4}\left(\frac{s\pi}{2}-\gamma\right)\left(\frac{s\pi}{2}-\gamma\right)\left(2\cos^2\gamma+1\right)\right.$$
$$\left.+3\sin\gamma\cos^3\gamma\,(1+\sin^2\gamma)-5\sin^5\gamma\cos\gamma+4\sin\gamma\cos\gamma\right].$$

Now the constant A depends upon the manner of setting the receiver into vibration. Our case is similar to the acoustical case treated by Lord Rayleigh.* The disturbing force which varies as $\cos\dfrac{2\pi x}{\lambda}$ is not applied at a single point, but is distributed over the distance $\dfrac{2\gamma\lambda}{2\pi}$. The disturbing force over one-half of this distance concerns itself with the Lecher system.

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* Theory of Sound. Vol. I, p. 189.

That over the other half has to do with the receiver. Accordingly we can take

$$A = \frac{A_o}{2}\int_0^{\frac{2\gamma\lambda}{2\pi}} \cos\frac{2\pi x}{\lambda}dx = \frac{A_o\lambda}{2\pi}\sin\gamma\cos\gamma \quad \text{and} \quad A^2 = \frac{A_o^2\lambda^2\sin^2\lambda\cos^2\lambda}{4\pi^2}.$$

Call $\dfrac{A_o^2 n_o}{16\pi^4 \kappa} = C.$ Then our expression for E becomes

$$E = C\lambda^4\sin^2\gamma\cos^2\gamma\left[s\gamma^2\cos^2\gamma\frac{\kappa_o}{\kappa}+\frac{1}{4}\left(\frac{s\pi}{2}-\gamma\right)\left\{\left(\frac{s\pi}{2}-\gamma\right)\left(2\cos^2\gamma+1\right)\right.\right.$$
$$\left.\left.+3\sin\gamma\cos^3\gamma\,(1+\sin^2\gamma)-5\sin^5\gamma\cos\gamma+4\sin\gamma\cos\gamma.\right\}\right].$$

Now Abraham's theory for the transmission of electric waves along a pair of parallel wires does not take into account the necessary bending of the wires leading up to the plates. For obvious reasons the ideal case shown in Figure 3 cannot be realized unless one has a rather large distance between the Lecher wires, which means a long bridge and larger phase-changes due to the bridge length. Blake and Sheard have shown that there are two factors, which they called θ (y) and $\phi(y)$ controlling the relation between the edge-on distance between the plates and the tone intensity. The former represents the electrostatic leakage to plates of the same circuit, the latter the phase-changes due to that portion of the wires at right angles to their main length. They have shown that these two factors act in opposite directions and the preceding paper confirms this. Abraham's theory does not consider either of these factors. We have made no attempt to determine the nature of either of these functions of y, (though the experimental data of Blake and Jackson are probably sufficient to determine both). They have determined, however, the optimum value of y for each frequency, that is, the value of y at which the tone intensity is a maximum. Obviously, this optimum value of y is that value at which these two factors nullify each other.

If then we compare the tone-intensities for the various optimum values of y they should agree with the simple theory of Abraham that neglects the two factors mentioned above. In making the theoretical calculations, however, some circumspection must be used. For instance, theory and experiment should not be expected to agree except at or near those values

of y where κ_0/κ is perceptibly constant, at least so long as the forms of $\theta(y)$ and $\phi(y)$ remain unknown.

Now in the work of Blake and Jackson the per cents of error were least for $y = 8$, as column 25 of their Table I shows as also does their Figure 7. We have carried through the calculation of E for the following values of y: 7.15, 8.0, 9.0, 11.1 cm., and have collected the results into Table I.

TABLE I.

y Cm.	λ_S Cm.	$\kappa_0\ \kappa$ Cm.	γ Degrees	Min.	$E \times 10^{-6}$ Arbitrary Units (C=1)	E Percent.
7.15	442.90		11	42.1	3663.2	100.00
	145.81		32	10.6	2143.6	58.52
	86.01	14.60	46	50.8	692.4	18.90
	60.47		56	36.5	209.0	5.70
	46.43		63	9.3	71.47	1.95
	37.58		67	43.3	28.77	0.78
7.15	442.90	14.60				100.00
	145.84	14.64				58.56
	86.00	14.58				18.89
	60.44	14.42				5.76
	46.34	13.71				2.12
	37.40	11.61				1.13
8.0	440.07		11	4.1	3107.3	100.00
	145.14		30	40.3	1921.0	61.82
	85.78	13.70	45	6.0	683.2	21.99
	60.41		54	56.3	220.6	7.10
	46.41		61	40.1	76.64	2.47
	37.60		66	24.3	32.33	1.04
9.0	441.00		10	37.8	2838.8	100.00
	145.62		29	36.5	1823.5	64.24
	86.19	13.17	43	50.0	691.5	24.36
	60.74		53	43.3	234.5	8.26
	46.71		60	33.4	86.20	3.04
	37.86		65	24.9	36.07	1.27
9.0	440.50	13.06				100.00
	145.60	13.15				65.56
	86.36	13.58				25.32
	60.88	13.84				8.23
	46.82	14.21				2.21
	37.94	14.48				1.12
11.1	440.28		9	39.2	2235.6	100.00
	145.68		27	12.5	1551.5	69.41
	86.45	11.92	40	54.3	677.8	30.32
	61.07		50	48.4	257.5	11.52
	47.01		57	53.1	98.38	4.40
11.1	439.28	11.63				100.00
	145.86	12.08				74.60
	87.00	13.12				34.09
	61.62	14.54				10.97
	47.40	15.33				3.61

The agreement between theory and experiment is remarkably good for $y = 8.0$ cm., or for the mean values for $y = 7.15$, 8.0 and 9.0 cm.*, as shown in Table II. Expressed in per cent the largest error is nearly eleven per cent, but when, as here, relative intensities are compared, it seems far more reasonable to express the error in terms of the fundamental intensity. When this is done the maximum error is less than one-half per cent. In the experimental work, although we tried to read to fractions of a division for small galvanometer throws, nevertheless such things as the wandering of the zero during a reading, slight unsteadiness of the zero particularly on windy days, together with slight errors of experiment, mentioned above but uneliminated, served to make the experimental error as high as five per cent, at least for the tones beyond the fifth.

TABLE II.

y cm.	ENERGY IN PER CENT					
	$S = 1$	3	5	7	9	11
7.15	100	58.52	18.90	5 70	1.95	0.78
8.0	100	61.82	21.99	7 10	2.47	1.04
9.0	100	64.24	24 36	8 26	3.04	1.27
Mean	100	61.53	21.75	7 02	2.49	1.03
Experimental	100	61 63	21.92	6.57	2 21	1.05

Expressed in per cent of the fundamental intensity the error is thus small and we can accordingly say that a satisfactory theory has been worked out to explain the observed curves of Blake and Jackson's Figure 6.

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* The value of κ_0/κ used in Table II is not exactly the value given in Table I of Blake and Jackson's paper. The calculation was made taking $\kappa_0/\kappa = 13.17$ cm., instead of 13.03 cm. This can affect our results but very little, for a change of 1 per cent in κ_0/κ with its consequent change in λ affects the relative intensity of the various tones from one to three per cent at most. The variation is not always in the same direction for the different tones, however.

Physical Laboratory, Ohio State University.

INLAND MOLLUSKS

Directions for Collecting and Preparing.

By V. Sterki.

Our land and fresh-water mollusca are very interesting objects of study, not only for their anatomy, physiology, life history, habits and classification, but also for their geographical and local distribution and their variation.

In Ohio, we have over three hundred species, with many varieties and local forms, but from a large part of the state the fauna is still insufficiently known. Good work can be done anywhere, toward an approximately complete survey. Besides, in working up the ecology of various places, the mollusks deserve consideration as well as any other group of animals.

LAND SNAILS.

These are found living in woods, copses, along old fences and railway embankments, swamps and marshes (especially their borders), banks of rivers and creeks above high water mark. They are generally more common on hillsides than on low ground and rocky slopes, especially of limestone, are often wonderfully rich. During the day, in fair weather, they are generally in their retreats, coming out at night, in the mornings and evenings and often on damp, dark days and after rains. Occasionally they ascend trees and other plants. As a rule, they will be found under and about old logs and stumps and in their cavities, under loose bark, pieces of wood, stone slabs and bricks, in crevices of rocks, old stone heaps, etc. Many are on the ground, under dead leaves and among thick plant growth. Some *Succinea* are frequently found along ditches, ponds and lakes, and often on reeds and rushes standing in water.

During winter, they hibernate, either in the same places, or buried in soft earth, muck, etc., often assembled in large numbers.

A very handy tool for collecting is a small, strong hoe, especially the "Ferris hoe." The blade of a garden hoe is trimmed to a point in the middle and thus made heart-shaped,

and sharpened, and the handle is sawed off to about three feet. For collecting under dead leaves, etc., a small rake is helpful and large stretches can be raked over in a short time.

The snails, as they are gathered, are put into a box or can, with some moss or leaves at the bottom. It is a good plan to have the box covered with canvas or soft leather, or still better, with a thin rubber sheet such as a piece of an old tire, with a slit in it. The snails can be put in easily and are prevented from crawling or falling out, and there is no bother in removing and putting on a lid. If the box is fastened to the belt, both hands are left free for work.

Snails with very thin, fragile shells, e. g. *Succinea*, should be kept separate, lest they be broken. The smallest should be put into a wide mouthed bottle or vial or better in a wooden pill box.

For a longer trip, in diversified country, several receptacles should be provided. The specimens from a hillside should not be mixed with those from lowlands, or from a swamp, etc. To each collection a label should be added at once, noting the locality, its nature, etc., and the date.

Naked or shelless snails or slugs should not be overlooked, especially species of *Philomycus*, which are from half an inch to several inches long when extended. They are mostly found under the loose bark of decaying logs or stumps. Large *Limax* may be found in cellars, under board walks, in nurseries, etc.

In greenhouses and nurseries, especially old, established ones, a number of snails and slugs can be found that have been introduced with plants, etc., chiefly from Europe.

Collect large numbers of specimens wherever possible. It is desirable to secure good, living snails, but even dead shells should be taken if they appear in any way different from living ones; they may represent different species, or forms, and "a dead shell is better than none at all" for faunistic purposes.

SMALL SNAILS.

More than one half of the number of species of land snails are small to minute, some measuring only one to two millimeters. These in part live at the same places with the larger ones, but are frequently found also among mosses, lichens, fine debris, etc. Large numbers of small Pupidæ are occasionally seen crawling on old stumps. They may be taken up

singly, e. g. on the point of a knife, and put into a vial or small box, but in general this is a tedious task and the results are not in proportion to the time spent. The better way is to collect them wholesale, so to speak. With a small brush, the under side of pieces of wood, stones, old bricks, etc., the fine dirt under loose bark or decaying logs and stumps is brushed down into a pan, or on a piece of paper. Fine debris and dirt around old trees and stumps, under brush heaps, etc., are scooped up and the whole material is taken along.

Dead leaves, debris, moss from the ground, wood, rocks, etc., are gathered on a large piece of paper, or preferably muslin, (I use one two yards square), gently worked with the hands, shaken well and gradually removed. A sieve is very helpful in separating finer particles and dirt along with the small snails and this material is carefully gathered. The leaves, moss, etc., if wet, may be spread out on the sheet and left for partial drying while other collecting is done; or if it is not far from home or camp, they may be taken along in a large sack or basket and taken care of there.

Some minute snails, like *Vallonia* and *Vertigo* often live in lawns of cities and towns, sometimes by the thousands. If not secured otherwise, they may be trapped on old boards, bricks, etc., which are improved for this purpose if smeared with meat or grease.

<div align="center">PREPARING.</div>

The larger snails are taken care of first and their soft parts must be extracted from the shells. A number of them are put in a tea strainer, or a piece of muslin, and immersed in nearly boiling water for about fifteen to thirty seconds, according to size, so that the columellar muscles are detached from the shells. Then the curved point of a long pin is stuck into the fleshy part, and the animal extracted, slowly and carefully, at the same time twisting the body or the shell. A safety pin, straightened out more or less, is convenient, making a handle at the same time. After some experience, one will succeed in removing the soft parts entire and will also know how long to scald for loosening the animal without "cooking" too much. If a part is broken off and left in the shell, the latter is filled with water and shaken vigorously, with the aperture closed, and as a rule the remnant can be washed out. Then

the shells are wiped clean, the inside with a wad of cotton or sponge, and left to dry.   Shells clothed with hairs, for example, *Polygyra palliata* and *P. inflecta*, should not come into contact with cotton.   Freshwater snails are treated in the same manner. The opercula of the operculate species should be kept with their shells, but not gummed in the apertures.

Of the soft parts extracted, at least some may be preserved in alcohol for future anatomical examination and they should be labelled carefully.   Especially specimens of doubtful identity must be marked so that they are referable to their shells. Alcohol of about 25% is used first, for a few days, then changed to 40 or 50% and after a week or two to 60% or 70%.

Specimens especially wanted for anatomical examination are best drowned in water (preferably boiled and cooled) in corked bottles placed upside down or in sealed jars.   In this way, they will extend more or less and the parts will be more in their natural position.   Slugs wanted for the collection may be treated the same way before being put in alcohol.

Small and minute snails are left to themselves for days or weeks, in wooden or pasteboard boxes, to give them time to retire deep into their shells, when they may be dried in gentle heat; medium sized ones may be scalded before drying.   They should not be dried in heat while fresh and this applies especially to those which have lamellæ and "teeth" in the apertures, or deeper inside, as *Pupidæ*, *Strobilops*, many *Zonitidæ* and the small *Polygyræ*, for the animals would emerge and obstruct those parts when dry, and thus make examination difficult or impossible.

SIFTINGS AND BRUSHINGS.

These when dry may be kept with their labels in boxes, paper bags or muslin sacks to be worked up at some convenient time.   They should be gently but thoroughly rubbed in the hands in order to detach specimens clinging to leaves, debris, etc.   Then, work is made much easier if finer and coarser materials are separated with a sieve or strainer, or with two of different meshes, or by shaking to and fro on a piece of strong paper.   Portion after portion is spread out on the table and the snails are picked out with a fine pair of pincers; very small and fragile shells are better scooped up or lifted with a moist camel's hair brush.   It is preferable to have a number of small boxes,

trays or dishes at hand, to separate the species at once, or at least the genera or groups. This will save a good deal of subsequent work and time.

After the specimens from a place are worked up, those of each species, if identified, are placed in a box, tray or vial. The latter may be corked if the specimens are perfectly dry, but otherwise should be closed with a wad of cotton or sponge.

DRIFT.

Drift accumulated along rivers, creeks, brooks, ravines, etc., after freshets and floods, in quantities from a handful or less to a wagon load or more, almost always contains mollusk shells, sometimes in large numbers and of many species. Generally they are dead shells, but these will be of interest for faunistics and often as "pointers" indicating the occurrence of a species or form which had not been found before. Fine drift is gathered up carefully and from heaps of coarse material it may be separated by sifting.

FOSSILS.

Fossil shells of land and fresh-water mollusks should be carefully collected wherever there is a chance for doing so. If the identity of the stratum cannot be ascertained, at least the locality should be exactly noted. Fossils have been collected at several places in the state, but not exhaustively, and there are probably others.

IDENTIFICATION.

This is often difficult for the beginner, especially with small and minute specimens. The best he can do is to send them to an expert or specialist, who will separate, name and return them. Send them all; often only a few are sent for naming and the balance kept, on the supposition that they are all identical, while two or several species may be mixed.

Siftings and brushings may be sent as they are, "dirt and all." Larger snails may be sent, separated or mixed up, with some moss or dead leaves to prevent jarring. Many a collector along other lines, an entomologist or botanist, may have chances to collect specimens and to gather brushings and siftings, which, by the way, may yield insects or other organisms of interest to himself. They will be of value in working up our fauna and make additions to the state collection.

TWO NEW TINGIDS FROM THE WEST INDIES
(HEM.-HETER.)

By Carl J. Drake,
New York State College of Forestry.

Leptodictya bambusæ sp. new.

Body elongate, narrow, very flat. Antennæ long, slender; first segment almost twice as long as the second; third segment very long, slender, nearly four times as long as the first and second conjoined; fourth segment broken off. Head armed with five, long, slender, semi-erect spines, the anterior ones extending slightly beyond the apices of the first antennal segments. Eyes rather large, globular, the facets large. Rostrum extending between the intermediate coxæ. Pronotum finely punctured, with the sides narrowed anteriorly, with three low carinæ; paranota formed as in *L. tabida* H.–S., with two rows or areolæ when viewed from above; the outer margin straight. Legs rather slender. Wings extending slightly beyond the tip of the abdomen. Elytra extending to far beyond the tip of the abdomen, the outer margins much less rounded and straighter than in *L. tabida* H.–S.; costal area widest near the middle, with three to four irregular rows of areolæ, the row of areolæ along the distal three-fourths of outer margins a little larger and more regular than the others; subcostal area narrow, biseriate, the areolæ small; discoidal area finely reticulated, extending a little beyond the middle of the elytra, with five rows of areolæ at the widest part; sutural area broad, the areolæ becoming larger towards the apex. Hood a little longer than broad, rather finely reticulate, covering the base of the head. Length, 2.65 mm.; width, 1 mm.

Color: Areolæ transparent, slightly irridescent, the nervures yellowish white. Thorax beneath reddish-brown, the abdomen testaceous. Legs testaceous, the tarsi darker. Head, eyes, and a small portion of the pronotum just back of the hood black. Bucculæ and rostral laminæ whitish. Antennæ whitish, the third segment slightly embrowned towards the apex.

Two specimens, taken on the leaves of bamboo, *Bambusa vulgaris* Schard., at Mayagues, Porto Rico, July 21, 1914, by Dr. R. H. Von Zwalenburg. It belongs to the group of *Leptodictya* which have the outer margins of the paranota distinctly

straight as in L. *tabida* H.-S. and L. *plana* Heid. and not
rounded as in L. *simulans* Heid. This species is probably most
closely allied to *L. tabida* H.-S., the sugar-cane Tingid, but
easily separated from it by the shorter spines on the head, the
much less rounded outer margins of the elytra, and the adven-
titious nervure in the discoidal area is wanting. *Type* in the
author's collection.

Leptostyla mcelfreshi sp. new.

Antennæ very long, slender, reaching beyond the apex of
the abdomen; first segment slightly swollen, straight, about
four times as long as the second, the second segment short;
third segment very long, slightly curved, slender, cylindrical,
about four times the length of the first; fourth segment sparsely
pilose, rather slender, equal to the first in length. Bucculæ
contiguous in front, broad, rather finely reticulate. Rostrum
extending between the intermediate coxæ. Pronotum finely
reticulate, tricarinate; median carina enormously elevated,
somewhat triangular, a little higher than the hood behind the
middle, quite widely reticulated, contiguous with the median
carina of the hood near the base; lateral carinæ composed of a
single series of large areolæ, widely separated from the base of
the hood, parallel with the median carina. Hood rather large,
widely reticulated, obliquely conical with the sides somewhat
flattened and the apex back of the middle. Paranota very
enormously expanded, not very broad at the base and becoming
narrower outwardly, widely and irregularly reticulate, the
areolæ becoming smaller towards the base, quite strongly
reflexed, the anterior and posterior margins slightly reflexed
and somewhat undulate, trough-shaped. Legs rather slender
and long. Head short, with five long slender spines, the frontal
spines directed forward, approximating at the tip and appearing
almost like a single spine, shortest; median spine semi-erect, a
little shorter than the first antennal segments; the two lateral
spines (one on each side) arising beneath the hood, extending
forward and strongly curved upward, slightly shorter than the
median spine. Wings not quite as long as the abdomen. Elytra
extending to far beyond the apex of the abdomen, diverging
posteriorly, distinctly constricted near the middle, narrowed at
the base and gradually widening, rounded at the tip; costal
area irregularly reticulate, narrowed at the base and apex, with

five rows of areolæ near the middle or widest part; subcostal area narrow, finely reticulate, with three rows of areolæ; discoidal area rather small and short, finely reticulate, with four rows of cells at the widest part, extending a little beyond the apex of the posterior triangular process of the pronotum; sutural area irregularly reticulate. Length, 3.6 mm.; width (elytra at constriction) 1.8 mm.

Color: Body beneath brownish. Legs testaceous, the tips of tarsi darker. Rostrum testaceous, the apex infuscate. Antennæ testaceous, the basal segment partially embrowned and the distal seven-eighths of apical segment dark fuscous. Bucculæ and rostral laminæ whitish. Areolæ mostly semi-transparent. Nervures yellowish-white, the marginal nervure of paranota, a few nervelets in discoidal and costal areas, a large spot on the median carina, and an oblique fascia (formed by the three nervures and nervelets connecting them) arising a little beyond the discoidal area and extending to the apex of each elytron brown. In this oblique fascia the middle nervure is lowered and forms a shallow furrow.

Two male specimens, taken at Port au Prince, Haiti, during the month of January. This species is most closely allied to *L. vesiculosa* Champion and *L. tumida* Champion, but readily separated from these species by the smaller hood, the longer spines on the head and the enormously developed paranota. *Type* in the author's collection. I have named the species in honor of the late Frank M. McElfresh, a great student, collector and worker in this group of insects. Some of the records published by Osborn and Drake in the OHIO JOURNAL OF SCIENCE (Vol. XVII) were taken from this collection. Although Mr. McElfresh had excellent knowledge of this group of insects and was preparing to monograph the Tingidæ of North America he left no notes or manuscripts and had published no papers on the Tingids.

Syracuse, N. Y.

The Editor regrets the delay in the appearance of the March issue of the Journal of Science. It was due to the loss of a large part of the proof in transmission.

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THE

Ohio Journal of Science

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CONTENTS.

INTRODUCTION.

The study of the parasites of the leaf-hoppers presents an interesting problem, not only from the practical standpoint, but from the biological as well. The economic status of the leaf-hoppers has been well established, and as a group they are now considered as including some of the more important insect pests. Therefore, their control by parasitism is significant as a natural check, and their parasites must be considered as dis-

tinctly beneficial.   This fact has been utilized in actual practice in control measures against the sugar-cane leaf-hoppers in Hawaii with marked success.

From the biological viewpoint, the study of the interrelations of these parasites with their host has a direct bearing upon the interesting problem of insect parasitism in general.   Thus the specialization of the dryinid, and the morphological changes it brings about in its host, the hopper, may and probably does have parallels in the relations between other groups of parasitic insects with their hosts.

These Homoptera are subject to parasitism in all their stages; namely, egg, nymphal, and adult.   In North America three orders of insects are known to contribute their quota of the parasites of this group—the *Hymenoptera*, *Diptera*, and *Strepsiptera;* and in Australia and Hawaii, certain of the *Lepidoptera* are considered to be parasitic, though this relation is not definitely established.

The eggs are known to be parasitized by species of the *Platygastridæ*, *Mymaridæ*, *Encyrtidæ*, *Eulophidæ*, and *Trichogrammidæ* (Perkins, 1905-1906).   The nymphs and adults are parasitized by the *Anteoninæ*, *Pipunculidæ*, *Strepsiptera*, *Epipyropidæ* and *Encyrtidæ* (Perkins, 1905) and *Chalcididæ* (Misra, 1917).

The relative importance of these parasites as natural checks varies probably in different localities.   However, in Ohio, at least in the northern half, the *Anteoninæ* are the most important. *Strepsiptera* have been recorded as being relatively numerous in regions further south, and their rather obscure habits and small size possibly may account for an underestimation of their importance in this locality.   Frequently their host survives and thus it seems that their attack is not always fatal.   Certainly, however, they form an important link in the chain of natural enemies.

The following paper is confined to an account of the *Anteoninæ*.   Material was more plentifully obtained for their study, and their greater importance warranted a more extended investigation.   Most of the parasites used in the life history studies were bred from hoppers taken near Sandusky and Columbus, Ohio.

HISTORICAL.

Latreille (1805) described *Lestodryinus* (*Dryinus*) *formicarius* which is the earliest record of description of a representative of this group. Jurine (1807) described a species which now forms the type of the genus *Anteon*. Ljungh (1810) described *Gonatopus formicarius* as the first apterous form and Dalman (1818) described *Aphelopus melaleucus*. Each of these species are typical of the four tribes into which the *Anteoninæ* are now divided.

The first host record was by Curtis in 1836, when he reported *Aphrodes craticula* to be parasitized in different stages by these parasites. Edward Perris in 1857 thought that *Platygonatopus* (*Gonatopus*) *pedestris* (Dalm.) was a hyperparasite of *Euscelis Athysanus maritimus*, believing that the larval sac was the primary parasite and distinct from the dryinid. G. von Frauenfeld (1865) mentioned *Platygonatopus* (*Gonatopus*) *pedestris* (Dalm.) in connection with (*Typhlocyba*). Since *Erythroneura* (*Typhlocyba*) is parasitized only by the genus *Aphelopus* in this family, it is probable that the host record is incorrect.

Lichtenstein (1874) reported rearing a species, *Gonatopus ptinorum* from the beetle *Ptinus fur* but Kieffer (1914) considers this species as *Cephalonomia xambeni* Giard of the sub-family *Bethylinæ*. From 15 to 20 larvæ were found in the cocoon of *Ptinus*, each spinning up an individual cocoon after issuing from the host (Kieffer '14). Dale (1878) mistook a probable dryinid larva for an Acarid and named it *Homopterophagus dorsettensis*. It was reared from a black, "mustard seed-like structure, noticed on the sides of diverse *Homoptera*, near the insertion place of the wings." According to Kirkaldy this was the larva of *Gonatopus*.

Mik (1882) described and worked out several important stages in the life history of *Gonatopus pilosus* Thoms. showing the true nature of the parasite to the host and disproving the hyperparasite theory.   Giard (1889) noticed and described the dryinid sacs attached to *Erythroneura hypocastani* in France and remarked upon the sac-like structure believing it to be a "true animal gall produced on an arthropod by another arthropod."   In a later article in this same year he succeeded in rearing the adult parasite which proved to be *Aphelopus melaleucus* Dalm.   He noticed the similarity of his own observations with regard to the hosts and life history with those of Perris (1857) and Mik (1882) and concluded that as a group the *Anteoninæ* were generally parasitic on the (*Jassidæ*) *Cicadellidæ*.   Giard also noticed certain secondary sexual modifications on the host caused by the parasite and that the hoppers were castrated.

Swezey (1903) reared both sexes of two dryinids from leaf-hoppers and these were identified by Ashmead.   He was thus the first one to associate the males of the more highly specialized apterous females and his true interpretation of the so-called genus *Labeo* in connection with these marks an important step in the knowledge of these insects.

Perkins (1905) gave a detailed account of the biology and life history of the *Anteoninæ*, together with descriptions of a large number of genera and species new to science, he having further divided the old genus *Gonatopus* into a number of distinct genera based on more exact structures than the general body form.   He also gave an extended host list and the next year supplemented this with new additions from Arizona.

Kieffer (1907) summarized the knowledge of the group to that year in a work that was primarily systematic and later (1914) monographed the group under the *Bethylidæ*.   Perkins (1912) in reviewing Kieffer's first paper added a number of new species, publishing four excellent plates figuring a number of typical *Anteoninæ*.

Keilin and Thompson (1915) worked out some very important points in the biology of *Aphelopus melaleucus* Dalm., especially with regard to the very early stages and the production and development of the peculiar hypertrophied tissue in the host.   In December of this same year and in 1916 Kornhauser worked out the biology of *Aphelopus theliæ*

Gahan, Mss. giving the first authentic record of a dryinid being parasitic on a membracid and also being the first one to observe polyembryony in this group. His work is concerned primarily with the effects of parasitism on the host.

Misra (1917) in working upon the Indian sugarcane leaf-hopper, *Pyrilla aberrans* Kirby, gave a number of pages to the discussion of the biology of the two dryinid parasites of this group.

SYSTEMATIC POSITION.

The *Anteoninæ* (*Dryinidæ*) are now generally considered to be a sub-family of the *Bethylidæ*, the latter being included in the super-family *Proctotrupoidea* of the Hymenoptera. A further discussion of the systematic relationships of these insects will be taken up in Part II of this paper.

METHODS.

All the parasites mentioned in the life history studies of this paper were bred, it being very difficult to capture adults in the field. All the hoppers were kept alive and the parasitized ones isolated in separate shell vials provided with a layer of damp soil and a cotton plug. Fresh leaves were added every day until the host had been killed by the parasite. When the latter had issued the host shell was preserved dry in gelatine capsules. If the hopper died before the parasite matured, it was preserved in 70 per cent. alcohol. The material for the morphological studies was sectioned, or dissected in cedar oil, being transferred into the latter directly from 70 per cent. alcohol.

DISTRIBUTION.

Geological.—Kieffer reports the genera *Dryinus* and *Chelogynus* from the lower Oligocene and Brues a new genus *Dryininæ* from this same stratum.

Geographical.—The *Anteoninæ* are found in all parts of the world and will doubtless be found wherever their hosts are abundant. According to Kieffer up to 1914 there have been 396 certain species described and 28 doubtful species. Of these, 200 have been described from the Palearctic region, 98 from the Nearctic, 65 Australian, 32 Neotropical, 16 Oriental, and 8 so far from the Ethiopian regions. To the list of countries Alaska may be added, one species of *Deltocephalus* being quite

extensively parasitized. It is probable that they are cosmopolitan in their distribution as a group.

Host Records.—As previously stated, the *Anteoninæ* confine their attacks to the *Fulgoridæ*, *Cicadellidæ* and *Membracidæ* so far as is known at the present, with but one record in the last named family.*

The following list summarizes the host records in so far as have been ascertained to date. The names and systematic position of the hosts have been arranged chiefly after Van Duzee's latest catalogue, (1917).

HOST LIST.

MEMBRACIEÆ.

Host Species	Stage of Host	Parasite Species	Authority	Location
Thelia bimaculata	nymphs	Aphelopus theliæ	Kornhauser	Evanston, Ill.

CICADELLIDÆ.

Sub-family *Bythoscopinæ*.

Host Species	Stage of Host	Parasite Species	Authority	Location
Agallia sanguinolenta	5th instar	?	F. A. F.	Marietta, Ohio. H. O.
Ipo sp.	nymph and adult	Parenteon myrmecophilus	Perkins	Queensland, Australia.
Eurinoscopus sp.	nymph	Chelogynus leiosomus	Perkins	Queensland, Australia.
Eurinoscopus sp.	nymph	Chelogynus nitidus	Perkins	Queensland, Australia.
Eurinoscopus sp.	nymph	Chelogynus dinudiatus	Perkins	Queensland, Australia.
Eurinoscopus sp.	nymph and adult	Chelogynus destructor	Perkins	Queensland, Australia.
Idiocerus sp.	nymph	Chelogynus cognatus	Perkins	Queensland, Australia.
Idiocerus pallidus	nymph and adult	?	F. A. F.	Corvallis, Oregon F. H. L.
? Macropsis	nymph	Chelogynus cognatus	Perkins	Queensland, Australia.

*Ratzeburg reported rearing *Aphelopus albipes* (Ratzeb.) from pupæ of *Bombyx pudibunda*, and Surface, *Phorbas longicornis* (Brues) from the cocoon of a microlepidopteron. Both of these records are doubtful and in the latter case it is probable that the cocoon of the dryinid itself was mistaken for the lepidopterous cocoon.

Sub-family *Jassinæ*.

Host Species	Stage of Host	Parasite Species	Authority	Location
Parabolocratus flavidus	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Scaphoideus immistus	Adult and nymph	. ?	F. A. F.	Venice, Ohio.
Tartessus syrtides	?	Chalcogonatopus gigas	Perkins	Queensland, Australia.
Euleimomos sp.	adult	Chelogynus parvulus	Perkins	Queensland, Australia.
Euleimomos sp.	adult	Chelogynus coriaccus	Perkins	Queensland, Australia.
Euleimomos sp.	adult	Pachygonatopus melanicus	Perkins	Queensland, Australia.
Euleimomos sp.	?	Gonatopus vitiensis	Perkins	Fiji.
Platymetopius pyrops	adult	?	F. A. F.	Clarksville. Tenn. D. M. D.
Platymetopius acutus	nymph	?	F. A. F.	Columbus, Ohio.
Phrynophyes sp.	?	Chalcogonatopus decoratus	Perkins	Queensland, Australia.
Deltocephalus sp.?	nymph and adult	Digonatopus australiæ	Perkins	Queensland, Australia.
Deltocephalus sp.?	?	Gonatopus dubiosus	Perkins	Queensland, Australia.
Deltocephalus sp.?	nymph	Chelogynus pallidicornis	Perkins	Queensland, Australia.
Deltocephalus sp.?	nymph	Chalcogonatopus optabilis	Perkins	Queensland, Australia.
Deltocephalus sp.?	?	Gonatopus ombrodes	Perkins	Columbus, Ohio.
Deltocephalus sp.?	nymph	Gonatopus vitiensis	Perkins	Queensland, Australia.
Deltocephalus sayi	adult	Gonatopus contortulus	F. A. F.	Castalia, Ohio.
Deltocephalus sayi	adult	Gonatopus n. sp.	F. A. F.	Columbus, Ohio.
Deltocephalus sayi	nymph	?	F. A. F.	Columbus, Ohio.

Sub-family *Jassinæ*—Continued.

Host Species	Stage of Host	Parasite Species	Authority	Location
Deltocephalus weedi	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Deltocephalus infumatus	adult	?	F. A. F.	Corvallis, Oregon. F. H. L.
Deltocephalus inimicus	adult	Gonatopus obscurrisimus	F. A. F.	Bay View and Columbus, Ohio.
Deltocephalus inimicus	nymph	Gonatopus erythrodes	F. A. F.	Castalia, Ohio.
Deltocephalus abdominalis	adult	?	F. A. F.	Katmai, Alaska. J. S. H.
Deltocephalus affinis	adult	?	F. A. F.	Bay View and Columbus, Ohio.
Deltocephalus oculatus	nymph	?	F. A. F.	Castalia, Ohio.
Deltocephalus oculatus	adult	?	F. A. F.	Castalia, Ohio.
Deltoeephalus balli	adult	?	F. A. F.	Columbus, Ohio.
Deltocephalus xanthoneuras ?	nymphs	Gonatopus pilosus	Mik	Vienna, Austria.
Deltocephalus silvestris	adult	?	F. A. F.	Mt. Katahdin, Maine. H. O.
Deltocephalus imputans	adult	?	F. A. F.	Lexington, Tenn. D. M. D.
Lonatura catalina	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Nephotettix sp.	nymph	Chalcogonatopus optabilis	Perkins	Queensland, Australia.
Nephotettic sp.	?	Gonatopus dubiosus	Perkins	Queensland, Australia.
Nephotettix plebius	adult	Gonatopus pulcherrimus	Perkins	Queensland, Australia.
Euscelis spp.	adult	Pachygonatopus melanias	Perkins	Queensland, Australia.
Euscelis sp.	?	Digonatopus koebelei	Perkins	New South Wales, Australia.
Euscelis sp.	?	Gonatopus pallidiceps	Perkins	California.

Sub-family *Jassinæ*—Continued.

Host Species	Stage of Host	Parasite Species	Authority	Location
Euscelis exitiosus	adult	?	F. A. F.	Wellington, Kas. E. O., G. K.
Euscelia humidus	adult	?	F. A. F.	Houlton, Bog, Maine. H. O.
Euscelis curtisii	adult	Gonatopus brunnescens	F. A. F.	Columbus, Ohio.
Euscelis maritimus	nymph	Platygonatopus pedestris	Dalman	Sweden.
Eutettix sp.	nymph and adult	Chelogynus nigricornis	Perkins	Queensland, Australia.
Phlepsius sp.	?	Chalcogonatopus pseudochromus	Perkins	Columbus, Ohio.
Phlepsius irroratus	adult	?	F. A. F.	Covington, Tenn. D. M. D.
Phlepsius truncatus	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Phlepsius apertus	adult	?	F. A. F.	Houlton, Maine. H. O.
Thamnotettix flavotinctus	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Thamnotettix crumbi	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Thamnotettix crumbi	adult	?	F. A. F.	Columbus, Ohio.
Chlorotettis unicolor	nymph and adult	Chelogynus n. sp.	F. A. F.	Castalia, Ohio, Corvallis, Ore. F. H. L.
Chlorotettix nacreosus	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Chlorotettix galbanatus	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Chlorotettix necopina	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Cicadula lepida	adult	?	F. A. F.	Clarksville, Tenn. D. M. D.
Cicadula sexnotata	adult	?	F. A. F.	Columbus, Ohio.

Sub-family *Typhlocybinæ*.

Host Species	Stage of Host	Parasite Species	Authority	Location
Dikraneura sp.	adult	Aphelopus arizonicus	Perkins	Nogales, Arizona.
Dikraneura fieberi	adult	Aphelopus n. sp.	F. A. F.	Columbus, Ohio.
Empoasca smargdula	adult	Aphelopus n. sp.	F. A. F.	Marietta, Ohio. H. O.
Empoasca mali	adult	?	F. A. F.	Columbus, Ohio.
Empoasca flavescens	adult	?	F. A. F.	Columbus, Ohio.
Empoa commissuralis	adult	?	F. A. F.	Mary's Peak, Ore., F. H. L.
Erythroneura sp.	?	Aphelopus microleucus	Perkins	Nogales, Arizona.
Erythroneura sp.	?	Aphelopus pulcherzimus	Perkins	Nogales, Arizona.
Erythroneura tricincta	adult	Aphelopus sp.	F. A. F.	Kelley's Island, Ohio.
Erhtyroneura comes	adult	Aphelopus n. sp.	F. A. F.	Columbus, Ohio.
Erythroneura obliqua	adult	Aphlopus sp.	F. A. F.	Marietta, Ohio. H. O.
Erythroneura vulnerata	adult	Aphelopus sp.	F. A. F.	Columbus, Rockbridge, O.
Erythroneura douglasi	adult	Aphelopus melaleucus	Girard	France.
Erythroneura hippocastani	adult	Aphelopus melaleucus	Girard	France.

Genus or Species Unknown or Record Doubtful.

Jassid sp.	nymph	Chelogynus lusus	Perkins	Tucson, Arizona.
Jassid sp.	nymph	Chalcogonatopus rapax	Perkins	Nogales, Arizona.
Jassid sp.	nymph	Digonatopus plebius	Perkins	Java.
Large green jassid on oak	?	Deinodryinus paradoxus	Perkins	Nogales, Arizona.
Medium sized jassid on willow	?	Anteon arizonensis	Perkins	Nogales, Arizona.
Jassid sp.	nymph	Chelogynus funestus	Perkins	Tucson, Arizona.

FAMILY FULGORIDÆ.

Sub-family *Dictyophorinæ*.

Host Species	Stage of Host	Parasite Species	Authority	Location
Thanatodictya sp.	nymph	Paradryinus javanus	Perkins	Java.
Hasta hastata	nymph	Paradryinus leptias	Perkins	Queensland, Australia.

Sub-family *Cixiinæ*.

Cixius contaminatus	?	Lestodryinus formicarius	Kieffer	Europe.

Sub-family *Tropiduchinæ*.

Vanua vitiensis	adult	Pseudogonatopus kiefferi	Perkins	Fiji.

Sub-family *Issinæ*.

Brucomorpha oculatus	nymph and adult	Phorbas mirabilis	Perkins	Columbus, Sandusky, Ohio.
Brucomorpha sp.	adult	Phorbas arizonica	Perkins	Nogales, Arizona.

Sub-family *Acanaloniinæ*.

Acanalonia bivittata	nymph	Hesperodryinus amphiscepæ	Perkins	Nogales, Arizona.
Acanalonia bivittata	nymph	Perodryinus amoenus	Perkins	Nogales, Arizona.
Acanalonia immaculata	?	Apterodryinus torvus	Perkins	Arizona.

Sub-family *Flatinæ*.

Ormenis prunosa	adult	Psilodryinus arizonicus	Perkins	Nogales, Arizona.
Ormenis septentrionalis	?	Psilodryinus arizonicus	Perkins	Nogales, Arizona.
Ormenis septentrionalis	adult	Psilodryinus ormenidis	Swezey	U. S.
Misthanophantia sonorana	nymph	Hesperodryinus arizonicus	Perkins	Nogales, Arizona.

Sub-family *Flatinæ*—Continued.

Host Species	Stage of Host	Parasite Species	Authority	Location
Misthanophantia sonorana	nymph	Apterodryinus torvus	Perkins	Arizona.
Privesa aphrophoroides	?	Neodryinus raptor	Perkins	Queensland, Australia.
Privesa aphrophoroides	nymph	Paradryinus venator	Perkins	Queensland, Australia.
Scolypopa sp.	?	Neodryinus raptor	Perkins	Queensland, Australia.
Gaetulia sp.	?	Neodryinus raptor	Perkins	Queensland, Australia.
Siphanta sp.	?	Neodryinus raptor	Perkins	Queensland, Australia.
Siphanta sp.	nymph	Thaumatodryinus koebelei	Perkins	Queensland, Australia.
Siphanta sp.	nymph	Paradryinus venator	Perkins	Queensland, Australia.
Siphanta sp.	nymph	Paradryinus threnodes	Perkins	Queensland, Australia.
Siphanta sp.	nymph	Paradryinus koebelei	Perkins	Queensland, Australia.
Siphanta sp.	nymph	Paradryinus varipes	Perkins	Queensland, Australia.
Sephena sp.	?	Neodryinus raptor	Perkins	Queensland, Australia.
Colgar sp.	nymph	Paradryinus leptias	Perkins	Queensland, Australia.
Colgar sp.	nymph	Paradryinus threnodes	Perkins	Queensland, Australia.
Colgar sp.	nymph	Neodryinus nelsom	Perkins	Queensland, Australia.
Colgar peracutus	nymph	Neodryinus koebelei	Perkins	Queensland, Australia.
Aphanophantia sp.	?	Neodryinus raptor	Perkins	Queensland, Australia.
Massila sp.	?	Neodryinus raptor	Perkins	Queensland, Australia.
Masilla sp.	nymph	Paradryinus venator	Perkins	Queensland, Australia.
Massila sp.	nymph	Neodryinus koebelei	Perkins	Queensland, Australia.

Sub-family *Delphacinæ*.

Host Species	Stage of Host	Parasite Species	Authority	Location
Stenocranus	?	Haplogonatopus vitiensis	Perkins	Fiji.
Stenocranus dorsalis	nymph	Pseudogonatopus stenocrani	Perkins	Ohio.
Perkinsiella saccharida	nymph and adult	Pseudogonatopus saccharatorum	Perkins	Queensland, Australia.
Perkinsiella saccharida	nymph	Echthrodelphax fairchildii	Perkins	Hawaii.
Hadeodelphax	nymph	Echthrodelphax nigricollis	Perkins	Queensland, Australia.
Hadeodelphax	nymph	Haplogonatopus moestus	Perkins	Queensland, Australia.
Aloha ipomeæ	nymph	Echthrodelphax fairchildii	Perkins	Hawaii.
Pyrilla sp.	nymph	Lestodryinus pyrillæ	Misra	India.
Pyrilla aberrans	nymph	Lestodryinus pyrillæ	Misra	India.
Pyrilla aberrans	nymph	Chlorodryinus pallidus	Misra	India.
Pyrilla perpusilla	nymph	Chlorodryinus pallidus	Misra	India.
Pyrilla pusana	nymph	Chlorodryinus pallidus	Misra	India.
Pissonotes dorsalis	adult	?	F. A. F.	Orono, Maine. H. O.
Bostaera nasuta	nymph	Agonatopoides synchromous	Perkins	Nogales, Arizona.
Stobaera sp.	nymph	Pseudogonatopus arizonicus	Perkins	Nogales, Arizona.
Stobaera sp.	nymph	Pseudogonatopus autoxenobius	Perkins	Nogales, Arizona.
Liburnia sp.	?	Pseudogonatopus americanus	Perkins	Columbus, Ohio.
Liburnia sp.	?	Pseudogonatopus opacus	Perkins	Queensland, Australia.
Liburnia sp.	nymph and adult	Pseudogonatopus dichromous	Perkins	Queensland, Australia.

Sub-family *Delphacinæ*—Continued.

Host Species	Stage of Host	Parasite Species	Authority	Location
Liburnia sp.	nymph	Pseudogonatopus perkinsi	Perkins	Hawaii.
Liburnia sp.	nymph and adult	Pseudogonatopus juncetorum	Perkins	Queensland, Australia.
Liburnia sp.	nymph and adult	Pseudogonatopus palustris	Perkins	Queensland, Australia.
Liburnia sp.	?	Pseudogonatopus kurandæ	Perkins	Queensland, Australia.
Liburnia sp.	?	Paragonatopus nigricans	Perkins	Queensland, Australia.
Liburnia sp.	?	Haplogonatopus brevicornis	Perkins	Queensland, Australia.
Liburnia sp.	?	Haplogonatopus apicalis	Perkins	Queensland, Australia.
Liburnia campestris	nymph and adult	Haplogonatopus americanus	Sweezey, Perkins	Columbus, Ohio.
Liburnia lutulenta	nymph and adult	Haplogonatopus americanus	Sweezey Perkins	Columbus, Ohio.
Liburnia verwandter	nymph	Echthrodelphax nigricollis	Perkins	Queensland, Australia.
Liburnia verwandter	nymph	Echthrodelphax bifasciatus	Perkins	Queensland, Australia.
Dicranotropis sp.	?	Pseudogonatopus nudus	Perkins	Java.

Genus and Species Unidentified.

Aphanophantia ?	nymph	Paradryinus koebelei	Perkins	Queensland, Australia.
Siphanta ?	nymph	Chloridryinus pallidus	Perkins	Queensland, Australia.
Fulgorid species	?	Antonella robusta	Dodd	Queensland, Australia.
Fulgorid species	?	Antonella bicolor	Dodd	Queensland, Australia.

Twenty-two genera, including forty-nine known species and five unidentified ones out of three of the six sub-families in the *Cicadellidæ* are known to be parasitized by the dryinids. Most of the host records are in the sub-family *Jassinæ* chiefly grass living forms. In the *Fulgoridæ*, twenty-six genera, including twenty-two species and four unidentified species are known to be subject to parasitism by these insects. In this family most of the host records are in the sub-family *Delphacinæ*. In all fulgorids the nymphal stages are the most susceptible to attack, the only adults parasitized being the weaker and less active forms. It is likely that nearly every species in these two families is subject to attack by one or more species.

DIAGRAM 1.

Interrelations of *Anteoninæ* with other parasites.

The above diagram represents graphically the inter-relations of the *Anteoninæ* and their hosts with other related parasites of these hosts. It is seen at once how small a part they play as a group in comparison with the other parasites in maintaining nature's balance. They are but one link in a very complex series. The leaf hoppers are parasitized also by the *Eulophidæ*, *Platygastridæ*, *Mymaridæ*, *Trichogrammidæ*, *Chalcididæ*, and *Encyrtidæ* of the *Hymenoptera*, by the *Pipunculidæ* of the *Diptera*, by the *Epipyropidæ* of the *Lepidoptera*, and by the

Strepsiptera. In addition to parasitizing the *Homoptera*, the *Anteoninæ* are themselves parasitized by the *Encyrtidæ* and *Eulophidæ*.

Aside from parasitizing the *Homoptera* most of the groups mentioned attack such other insect groups as the *Hemiptera*, *Coleoptera*, *Diptera*, *Orthoptera* and *Hymenoptera*. In comparison with the other groups it is noted that the *Anteoninæ* and *Pipunculidæ* are narrowly restricted in their range of hosts.

BIOLOGY AND LIFE HISTORY.

Adult.—The adult dryinids are found living in grasses, herbage and trees, in fact wherever their hosts, the leaf- and tree-hoppers, are found. The females are much more active, continually running and flying about in search of their prey. In species where the female is wingless, the habits of the two sexes are very different, the males generally being found resting on the leaves and stems, or flying about in search of the females. In describing the habits of *Lestodryinus* (*Dryinus*) *pyrillæ* Kieffer, Misra (1917) says: "The adult females are very active and may be seen actively flying about the leaves, occasionally settling down, especially near the nymphs, and then flying away. The adults are prominent mostly during the hottest part of the day." Later in the same paper, speaking of *Chlorodryimus pallidus* Perk., he says: "It is the female which is mostly in evidence in the fields when the leaf-hopper is present in numbers on the canes. The male is rarely seen about the infested fields."

Not all winged dryinids are as active as Misra has observed, for Perkins (1905) says: "The prey is sought on foot, for while most of the *Anteoninæ* (*Dryinidæ*) are most active and rapid runners, they are but poor performers on the wing. In most of the winged forms, these organs are unduly short, and in *Echthrodelphax* serve hardly more than to transport it from one cane plant to another as occasion demands." There seems to be no correlation between the presence of wings in this family and the habit of attacking arboreal hoppers. Perkins (1905) noticed that in Australia and generally in America, the apterous forms of the *Gonatopus* type preyed upon hoppers that fed on grasses and low herbage. "On the other hand," he says, "the Hawaiian apterous species are essentially arboreal."

Mimicry.—Along with the loss of wings in the female, there has been developed the remarkable resemblance to ants in many forms. This has been adaptive and due entirely to the mode of life of the female. Not only have the wings been lost, but the legs have been modified for running, and the forelegs especially for grasping the prey. Thus the thorax has become greatly modified and more closely fused with the propodeum. In the more highly specialized species, many of the thoracic sutures have been obliterated and segmentation of the thorax is indistinct. The latter is divided into two nodes by the narrow mesonotum, and may even be divided into three nodes. This division of the thorax and the pedunculate form of the first abdominal segment are adaptations to the stinging habit of the female, enabling her to bend the entire body in an arc while stinging the prey.

Many species have evidently taken advantage of this ant-like form and are frequently found associated with ants, sometimes being found in the nests of the latter. This association in the case of *Platygonatopus pedestris* (Dalm.) was observed by Haliday in 1834, when he says: "The first time I met with this species, it was in company with some *Myrmicæ* (not M. *rubra*), under a stone, in a chalky lane. * * * In this island, its haunts are on the sand-hills of the coast, among which *Formica emarginata* swarms. The Dryinus, which is not dissimilar in form and color, moves among them distinguished by its hitching gait, produced by the enormous length of the tarsi and trochanters of its forelegs; it can run pretty fast, however. * * * I witnessed an occurrence which shows that it is not always quite amicable. Four ants were bearing off one of the Dryinii quite alive and vigorous, though not able to struggle much in their grip; my approach disturbing them, three scampered off, but the fourth, more determined, held on; the *Dryinus* however, as soon as she got fair play, showed fight, and though her small jaws seemed ill calculated to match those of the ant, the battle was maintained without any visible disadvantage. * * * " Perkins (1905) says that "*Paranteon* no doubt has special habits; for the sluggish hopper that it affects, forms flocks of greater or less extent, and excreting much honey dew, is invariably covered with swarms of ants, usually a moderate-sized species of *Formicidæ*. The *Paranteon* bears some slight resemblance to the ant in appear-

ance, and this resemblance is enhanced by its actions.   If a number of parasites be bred together in a glass vial, they may be seen gathered in pairs, standing sub-erect on their four hind legs, face to face, stroking one another, licking each other's mouth, soliciting food.   Now the ants that attend the hoppers themselves behave in a similar fashion, and it is most probable that they actually feed the *Paranteon*, which unless it were on friendly terms with the ants, could never approach the hoppers to lay its eggs in these.   *   *   *   Further, it would be interesting to note what happens to the full-grown larva of the parasite, which must emerge from its sac amongst a swarm of carnivorous ants that are always prepared to kill and carry off any weaker insect that falls in their way.   Most probably not only are the larvæ not harmed by the ants, but they may be carried down by them to their underground nest, and pupate therein.''

There are several records of dryinids being collected in ants' nests.   The following species have been recorded as associated with ants: *Dicondylus distinctus* (Kief.), England, in colony of *Myrmica; Dicondylus striatus* (Kief.) Austria and England, in nest of *Formica fusca;* and *Gonatopus Myrmecophilus* (Kief.), Luxemburg and England, with *Formica rubibarbis.*

Apterous species are often collected by turning over stones, and are very rarely reported as being taken in the net, although this may be due to their close resemblance to ants.

Both sexes feed readily on water sweetened with sugar. Perkins (1905) noticed individuals of *Echthrodelphax* feeding on the honey-dew secreted by their host, a certain fulgorid. They may attack and devour their host, for the same author says that ''under unnatural conditions, such as in the confinement of a small jar or glass tube, and probably under pressure of hunger, the hoppers are frequently killed outright, and to some extent devoured.''   In the act of oviposition, the female invariably works her mandibles on the cuticle of the hopper, and sometimes produces a wound which in some cases so weakens the hopper as to cause its death.   Again no sign of a wound is noticed after oviposition.

The longevity of the adults varies with the sexes, the female invariably being much the longer lived.   In fact, the males live often but a few days, often only for a day.   Frequently, according to Perkins (1905), the male dies after copulation. The female may live as long as seventeen days in captivity, and undoubtedly much longer under natural conditions.

In the species studied, the act of pairing was unobserved. In spite of the fact that with *Gonatopus erythrodes* (Perkins) and *Haplogonatopus americanus* (Perk.) males and females were placed together for observation under as natural conditions as possible, neither sex paid any attention to the other. The females were constantly running around among and over the grass-blades as if searching for their prey. On the other hand, the males were as a rule inactive, resting upon the sides of the cage or on the grass leaves. Perkins (1905) concerning *Echthrodelphax*, states that "pairing of the sexes is of short duration, and after copulation the male frequently never moves again, and in general dies very quickly."

Parthenogenesis occurs probably to a considerable extent in this sub-family. This has been proven in captivity, and undoubtedly occurs to some extent under normal outside conditions. The great disproportion of sexes in some species, and the fact that with others males have not been found, seems to bear out that statement. In commenting on *Pseudogonatopus* Perkins (1905) says that but one in forty adults was a male. Males have not been either captured or bred from species of *Eugonatopus* or *Agonatopus*. Adults from unfertilized eggs of *Gonatopus contortulus* Patton were all females, and were normal and active in every way.

Polyembryony has been recorded for this group in the case of *Aphelopus theliæ* Gahan ms. parasitic on *Thelia bimaculata*.

The method of attack and oviposition is very similar for nearly all species of the *Anteoninæ*. Upon nearing the prey the female comes to a standstill, throwing her antennæ backward and swaying from side to side before making her jump. She then throws herself upon the hopper, which may escape by a quick jump. The chelate claws of the forelegs are thrust out at the same time, and the prey is seized in this manner. Once the hopper is captured, the female grasps it with all six legs, and placing her body sidewise across that of the struggling host, curls the tip of the abdomen under and thrusts the sting in the ventral side of the thorax in the case with *Gonatopus erythrodes* (Perk.) and *Haplogonatopus americanus* (Perk.) as observed by the writer, and with *Echthrodelphax* as noted by Perkins (1905). With *Gonatopus contortulus* Patton, however, the host is large and robust and winged, so that the method of attack is varied. Here the prey is stalked from behind, and

while clinging to it with the front pair of legs, the sting of the dryinid is thrust forward beneath her body and into the ventral side of the abdomen of the jassid.   If the latter jumps, both fall to the ground; and in this case the process of stinging is similar to the above-mentioned species. With other species the sting is thrust in different places on the host, according to various observers. While the hopper is struggling, the parasite may be seen trying to locate a vulnerable spot in its host's armor. This always seems to be in the thin membrane separating adjacent segments. Once stung the hopper is paralyzed, and it is then dragged to a convenient place for oviposition. In several instances the parasite dragged the stunned jassid around the vial for some time before stopping to oviposit. In doing this the mandibles are used, the wasp backing around, dragging the host after it. In many cases the host was oviposited in immediately. In the case of opaque nymphs, before the ovipositor is inserted, the sting can be seen working this way and that with extreme rapidity, just beneath the cuticle. It is finally withdrawn, and the ovipositor thrust in deeply into the body of the nymph, and the egg laid. The entire operation extends from one to often two or three minutes.

In *Gonatopus contortulus* Patton the egg may be laid on the outside of the cuticle, although it is more often thrust beneath it. In a *Gonatopus* species parasitic on *Deltocephalus inimicus* nymphs, the egg is thrust down between the segments, the tip just protruding outside.

Perkins (1905) remarks that "occasionally after capture, the prey is released without being stung, and that it is probable that hoppers so released have already been stung by an earlier captor." The writer is inclined to doubt this as the real explanation, since more than one larval sac is often found on one host. Once a nymph was found bearing a nearly mature larval sac and an egg just protruding externally between the segments. As there was only enough food present in this nymph for the maturing of but one parasite, the fate of the youngest dryinid is obvious. It is evident that it is just a matter of chance whether the captured nymph has been previously parasitized or not, and that when the female does not oviposit the cause must be something other than that of previous oviposition.

In some species there is just enough food present in the hopper to feed but one dryinid, while others may be seen bearing from two to as many as eight parasites. In fact, with *Brucomorpha oculatus*, two or three parasites are more often found attached than one, and these may all mature if the host is a large, robust individual. Generally the parasites on a hopper are of one species, but may be of two different species. One sex seems as readily attacked as the other. Some species confine their attacks entirely to nymphs, others to adults, and others to both nearly mature nymphs and adults. Once a nymph is parasitized it never becomes adult, in so far as observed by the writer. Keilin and Thompson (1915) state that the *Typhlocybidæ* parasitized by *Aphelopus malaleucus* Dalm. are oviposited in before becoming adult. With *Erythroneura tricincta*, parasitized also by a species of *Aphelopus*, adults have been kept in captivity as long as a week before a sac appeared externally. It would seem, then, that with this species the egg is laid after the host becomes winged. Nymphs parasitized by *Gonatopus* and its allies never become adults, no matter if they are in their last instar. *Gonatopus erythrodes* (Perk.) attacks nymphs in the second, third and fourth instars, but prefers nymphs of the fourth instar. The place selected for oviposition with a given species of dryinid is generally restricted not only to either the abdomen or thorax, but also to certain segments of these, or in certain positions on these segments, as, for instance, with *Haplogonatopus americanus* Perk. Its sacs are found invariably protruding dorsally between the last two or three abdominal segments. Very often a species of dryinid confines its attacks to one species of hopper. Others may parasitize closely-related species; and still others may parasitize species in different genera.

After oviposition the dryinid drops the hopper and runs away. The latter recovers rapidly, and generally within five minutes recovery is complete and feeding is resumed. The number of eggs a female may lay is probably considerable, though not as large as with many hymenopterous parasites. In captivity the largest number of eggs obtained was thirteen, and the greatest number in a single day was six. These figures are unquestionably much too low for normal conditions. The females are ready for oviposition as soon as they have fed after emergence, so that the oviposition period must extend through-

out the entire period of adult life, probably a month in nature. Basing the above number of eggs per day on this period of oviposition, the maximum number of eggs that can be laid is one hundred and eighty.

Egg.—Since the egg is very minute and often is thrust down deeply into the body, it is practically impossible to locate it either by dissection or by sectioning the host.   For this reason, the date of hatching is still in doubt, and the incubation period can only be estimated from the time the egg is laid to the appearance of the sac outside the body-wall of the hopper. In *Gonatopus erythrodes* (Perk.) a blackish discoloration precedes the appearance of the sac by several days, and is noticed five days after oviposition.   Since in this case the discoloration is due to the black sac beneath the cuticle, the egg must have hatched within two or three days after being laid.

Larva.—The earliest stages of the dryinid larva have been described by Keilin and Thompson (1915) for *Aphelopus malaleucus* Dalman parasitic on *Erythroneura* (*Typhlocyba*) *hippocastani*.   They report finding an embryonic stage within the tissues of the host, and do not consider it as the first larval stage.   The exact relation of this "embryo" to the first stage larva is not known.   It is possible that this may be the true first instar, which may be modified and different from the following ones.   In case the egg is internal, just previous to emerging from the host, the larva is seen to be curved into the form of a U, the apex of which appears first between the segments.   This is the second larval stage, and it is covered almost entirely and protected by the exuvium of the first instar.   The appearance of the sac externally on the host takes place in from five to seven days after oviposition.   During this time the egg has hatched, the "embryonic" stage has been passed, and a molt has taken place.

The second molt occurs in from five to ten days after the emergence of the sac, and is indicated by the rupturing of the first exuvium along a median dorsal line.   Between the gaping halves of this split, the second exuvium is gradually pushed outward by the growth of the larva within, now in its third instar.   Accompanying this split there is often a change in the coloration of the sac, as from dark green to black.

As growth occurs, the second exuvium becomes split open in the same manner as did the first, a fact coincident with a third larval molt, and the third exuvium is pushed outward by the larva, now in its fourth instar, exactly as before. The fourth larval stage is not comparable to the other four. It is characterized by the development of the mandibles, beneath which are formed those of the fifth stage. There is no complete fourth molt, so far as is revealed by dissections, other than a shedding of the head capsule. It is possible that this instar is entirely eliminated in some of the more highly specialized species. The larval sac has become of considerable size by now, and is plainly visible on nymphs and brachypterous forms. In winged species, the sac pushes one wing and elytron up out of place. The host becomes very evidently affected by now, being sluggish and easily caught. In from eighteen to nineteen days after the appearance of the sac the fourth partial molt occurs, and the larva enters upon its fifth and last larval instar. Up until this time it has not touched any vital part of the host. The mouth-parts of all the preceding instars are soft and slightly chitinized, while in this last stage, sharp, heavily chitinized mandibles are developed and the tissues of the host are devoured. Growth is now very rapid, and soon the larva breaks through the sac, first being seen as a narrow white band between the slightly gaping halves of the exuviae. Peristaltic-like movements take place spasmodically in the maggot, which increases visibly in size. In the case of *Gonatopus erythrodes* (Perk.) parasitic on *Deltocephalus inimicus* nymphs, the last stages are easily studied as the host is not very heavily chitinized and opaque yellow in color. The dark jaws of the parasite can be seen working in the interior of the host's abdomen first. The entire abdomen is emptied of its contents before the parasite directs its attention to the thorax. At this time, an hour after the last molt, the hopper is still alive and responds to stimulus, but it now dies very quickly as soon as the thoracic viscera are attacked. The feeding seems to be a combination sucking, in which the cone-like labium functions and the cutting by the sharp mandibles. The head is attacked after the thorax, and soon there is nothing left of the hopper but a mere shell. The contents of the host seems to be partially liquified at the final stages. About two hours elapse between the final molt and the consumption of the host.

Coincident with the growth of the parasite is the formation
and development of the sac. (Figs. 1-7). When the larva
hatches it is generally entirely or almost within the body of
the host and surrounded by its tissues. As it grows it gradually
assumes a curved position, due either to unequal growth or
pressure against the host's tissues. It also pushes its way along
the path previously made by the ovipositor toward the external
point of insertion of the latter. If the egg is laid internally,
it undergoes its first molt still within the body of the host, as
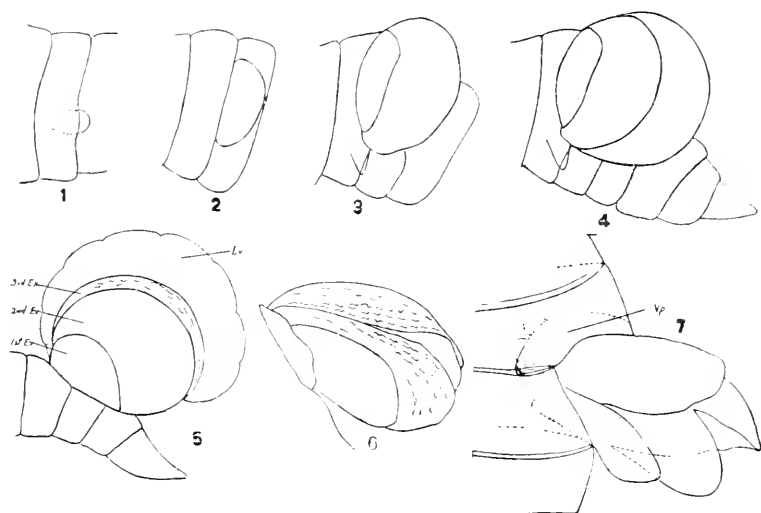
FIGURE 1.

1-6, side view of abdomen of *Deltocephalus inimicus* nymphs, showing stages in
parasitism by *Gonatopus* sp.; 1, egg; 2, second instar; 3, third instar; 4, fourth
instar; 5, fifth instar; 6, empty sac; 7, dorsal view of abdominal segments of *Delto-
cephalus sayi* adult showing empty sac of *Gonatopus* sp.; 1st, 2nd, and 3rd. Ex.,
first, second and third exuviæ; Lv., larva; Vp., ventral larval process.

noted; and instead of entirely breaking through the exuvium
dorsally in the normal manner, it splits the latter ventrally and
uses it as a buffer in forcing its way outward. It becomes
more and more curved in position, and finally breaks through the
cuticle of the hopper still with the protection of the first exuvium,
which surrounds it as a sort of hood. At no external point,
then, is the larva exposed, but with its head and caudal end still
in the tissues of the host, it feeds and the first exuvium becomes
fused with the cuticula of the hopper by a series of chitinous
hooks or other means. At the second molt, the second exuvium

is split ventrally as was the first, and it is pushed outward by the growth of the third instar within, breaking through the first exuvium which is firmly attached to the host. This process is repeated in the third molt, the second exuvium becoming split open by the third. The exuviæ become chitinized and darken in color in some species. In *Phorpas mirabilis* (Perk.) parasitic on *Brucomorpha oculatus*, this darkening and hardening of the exuvium begins in the region of the spiracles, and at first there is on each segment an oval black spot around each. These later become confluent and it seems that apparently after the skin is shed the air has something to do with the hardening of the exuvium. The exuvium just shed also adheres very closely to the growing larva which at first breathes through the spiracles of this cast skin. Tracheae can be seen in direct connection between the first pair of spiracles, even in the late phase of this instar. Just before the fourth molt, then, there is present the fourth instar parasite larva, protected dorsally by the third exuvium and laterally by the first and second. During the late phases of the second instar, the parasite pushes itself completely outside of the host, remaining attached by the chitinous ring of the sac only, and with its head and posterior extremity just within the body of the hopper. Later on the head alone remains within the body of the host.

With the final consumption of the host, the maggot withdraws its head from within the shell of the latter, which it quits, and goes off in search of a place to spin its cocoon. In some species the dead shell of the host is jerked abruptly away by the maggot (Misra, 1917). The larva is quite active, and crawls around on its back similar to a *Cotina* grub by peculiar peristaltic like movements, originating at the caudal end as a constriction which progresses anteriorly. Sometimes as long as a day is spent before the cocoon is started, and again it is begun almost immediately, even beneath the dead host (Swezey, 1903). The cocoons are spun either beneath the soil or above it on leaves or other objects. Sometimes there is variation in individuals in regard to the location of the cocoon. The first generation cocoons of *Gonatopus erythrodes* (Perk.) were spun below the soil, but some of these of the second were spun above the soil on the sides of the cages. The cocoon is completed in from one to two days, although larvæ that are to pass the winter may be seen lining their cocoons for days after they are apparently finished.

Pupa.—Directly after completing the cocoon, the larva becomes quiescent, and within one or two days assumes a straight, rigid shape, becoming a prepupa. After five to seven days pupation occurs, the larval skin being pushed down into the bottom of the cocoon as a tiny crumpled mass. The time spent in the pupal stage varies greatly—from three to five weeks with different species. At the end of this time, the adult issues, but does not as a rule emerge from the cocoon until two or three days later. It then chews its way out at or near one end, and is ready for active life immediately. The total life cycle varies from a year to as low as forty-three days.

SEASONAL HISTORY.

Hibernation.—All species of the dryinids studied by the writer have so far passed the winter as larvæ within the cocoon; and this is probably true of the great majority of them. A few got as far as the prepupal condition, but all larvæ collected in September and late August remained as such. There seems to be no difference in the structure of the winter and summer cocoons.

Generations.—The number of generations a year depends upon the species of host attacked, and of course upon the climate. Species attacking a host that has two generations a year—as with *Gonatopus erythrodes* (Perk.) parasitic on *Deltocephalus inimicus*—have the same number of generations. Others have but one. Two generations a year seems to be the maximum in this latitude, though farther south there are probably more. When a species attacks but one stage of its host, it must spend most of the year in the cocoon, issuing only when the right stage of its host is present. In one case, that of *Chelogynus chlorotettixi* n. sp. parasitic on *Chlorotettix unicolor*, the nymphs of which are found only in June in the Lake Erie region, spins its cocoon in early July and remains as an active larva within its cocoon throughout the remainder of the summer until the next spring, when it pupates and emerges in June in time to attack the nymphs of its host. One cocoon of this species was carefully split open in September, and an active white larva revealed. Later it was noticed that this larva had spun over the slit in its cocoon.

In some cases, where there are two generations a year, part of the larvæ of the first will pupate and the rest will remain

as larvæ until the following spring. A similar instance was noticed by Perkins (1905) in the case of estivating larvæ. He says: "The number that remain as larvæ, when others emerge after the usual period, may amount to not less than twenty-five per cent." From two thousand cocoons of (Dryinus) sent to Perkins in Hawaii from North America and arriving there in November, two males emerged a few weeks after arrival, and one male a month later. After being removed to a cooler and damper place, both sexes issued in a short time. This retarding of development is characteristic not only in localities where winters are long and severe, but also where a hot, dry period is experienced. It is a phenomenon that has been noticed with other insects, and is a means probably of insuring a continuance of the species in case the immediately following generation is not successful and perishes for want of food.

DESCRIPTION OF STAGES.

Egg.—The egg of the *Gonatopus* species studied (Figs. 8 and 9) is either oval or kidney-shaped, and varies in color from light yellow to dark grey or dark brown. In length it averages from .15–.211 mm. and in width from .08–.095 mm. There is no sculpturing on the chorion of any studied and in the case of those laid within the body of the host, no surface structures. In one egg, that of a *Gonatopus* species on *Deltocephalus inimicus* nymphs, a circular ridge, hardily visible, was noticed at one pole, and a black excrescence about half way down on one side. When laid on, or partly exposed on, the cuticula of the host it may be of the same color and almost invisible, as in *Gonatopus contortulus* Patton, or its color may be sharply contrasted with that of the host.

Larva: *First instar.*—The earliest stage found was that of a larva within its egg shell ready to hatch (Fig. 10). It was structureless, with no visible appendages or segments. A small dark brown spot present at one extremity might serve for the purpose of breaking open the egg chorion, which is comparatively hard and thick.

Second instar.—The second instar of *Aphelopus comesi* n. sp. was studied, (Fig. 11). The specimen observed measured .54 mm. in length and .23 mm. at its greatest breadth near the head region.

The posterior third of the body is flexed downward and forwards, the anal extremity pointing cephalad. Two lobed processes projecting dorsally from the cephalic region are the
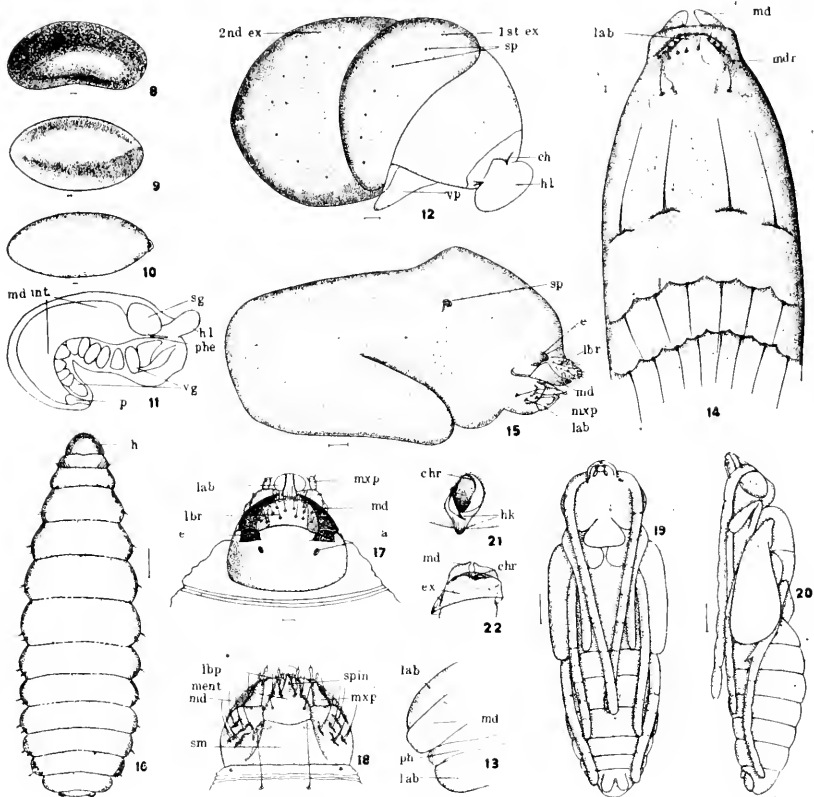
FIGURE 2.

8, egg of *Gonatopus* sp.; 9, egg of *Gonatopus erythrodes* (Perk.); 10, first instar of *Gonatopus erythrodes* (Perk.); 11, second instar of *Aphelopus* sp.; 12, third instar of *Gonatopus contortulus* Patton; 13, side view of mouth parts of fourth instar of *Anteon* sp.; 14, dorsal view of fourth instar of *Aphelopus* sp.; 15, fifth instar of *Gonatopus contortulus* dissected from sac; 16, dorsal view of mature larva of *Gonatopus* sp.; 17, dorsal view of head of *Gonatopus* sp., mature larva; 18, ventral view of head of *Aphelopus* sp., mature larva; 19, ventral view of male *Haplogonatopus americanus* pupa; 20, side view of same; 21, cavity in body wall of *Erythroneura comes* produced by *Aphelopus* sp.; 22, dorsal view of head of *Aphelopus* sp., fourth instar showing relation to larval sac, and chitinous ring. 1st, 2nd., and 3rd. Ex., first, second and third exuviæ; Vp., ventral larval process; md. int., mid intestine; sg., supra-esophagial ganglion; hl., head lobe; phe., pharynx-esophagus; vg., ventral nerve chain; p., proctodeum; h., head; spin., spinneret; ch., chitinous head process; e., eye; lbr., labrum; md., mandible; mxp., maxillary palp; lab., labium; a., antenna; lbp., labial palp; sp., spiracle; ment., mentum; sm., sub-mentum; ph., pharynx; mdr., developing mandibles.

only mouth parts. A large mid-intestine beginning just back of the head extends throughout the greater length of the body to near the anal end. The pharynx-esophagus is a very narrow tube, distinguished below the supra-esophagial ganglia. The hind-intestine is contiguous with the mid-intestine, but there is no connection between the two. In *Aphelopus melaleucus* Dalm., according to Keilin and Thompson, the salivary glands are very long and have a winding course. They were not seen in the specimen studied by the writer. Twelve ventral ganglia are easily distinguishable, the two anterior of which are doubtless thoracic and cephalic. The second is connected with a more or less elongated ganglion located just ventral to the first or sub-esophagial ganglion. The above mentioned authors report finding fourteen ganglia in the ventral nerve chain of *Aphelopus melaleucus* Dalm. instead of twelve, which is the ordinary number in other Hymenopterous larvæ. Nine pairs of spiracles are present in this stage.

Third instar.—In this stage the larva assumes a more marked curved position, being bent ventrally in the form of a U, the cephalic and caudal ends being approximate, (Fig. 12). The head and anterior third of the body lie buried in the tissues of the host, the rest of the larva protruding externally. It is completely enclosed in the second exuvium, except the head region. The first exuvium lies midway across each side of the body. In some species the ventral portion of the body immediately back of the head is prolonged into a peculiar appendage, which is enclosed by a cone-shaped membrane, the cuticle of the second exuvium. This is turned outwardly and posteriorly and its tip lies just beneath the chitin of the host at the juncture of two metameres, and is often visible externally in the case of light colored nymphs as a dark brown process extending under the cuticula from the point of attachment of the parasite. Often there is no corresponding larval tissue within this and in this case a small opening is noticed at the tip. It may serve to tap the outside air and thus keep a supply under the second exuvium for the enclosed larva. There is no connection between the spiracles of the second exuvium and the larva unless the thoracic pair retain this as they do in the next stages. The mouth parts are similar to those of the preceding stage except that they are larger. In *Gonatopus contortulus* Patton they appear as two oval, fleshy lobes projecting prominently from the head

region. At their bases the head is constricted visibly and at this constriction there are four triangular chitinous processes. These lobes may represent the mouth parts alone and may also be considered as the rudiments of the head. They are very firmly embedded in the tissue and are often detached and overlooked. Eleven distinct ganglia of large size comprise the ventral nerve chain, the first two being the largest. Beneath the second exuvium the cast tracheae and their branches can be seen. Nine spiracles are present.

Fourth instar.—The exact status of this stage is not yet determined. It is indicated only by the characteristic mouth parts, (Figs. 13 and 14), and the exuvium has not been noticed if indeed there is more than a molting of the head parts. It is obvious that the change from the peculiar soft lobed mouth parts of the third instar to the heavy chitinized mandibles of the last instar is too abrupt and that there must be an intermediate stage probably having been mostly suppressed with the specialization of the group. The mandibles in this stage are distinct curved processes with broad rounded and notched tips, thinly chitinized. A simple truncate labrum is present. Shortly after this stage has been reached the fifth instar mandibles develop back in the head, the point of each projecting into ·the base of the fourth instar mandibles. This instar is not represented by any of the three exuviæ composing the larval sac.

Fifth instar.—Shortly before the appearance of the larva from the larval sac the mouth parts of the last instar are completely developed, and larvæ dissected out of sacs showing the three larval exuviæ present the same type of mouth parts as the mature free-living larva, (Fig. 15). Though fully developed late in the preceding stage the cutting mandibles do not function until this instar. The mouth parts are represented by the rounded labrum, the dark brown, curved, sharply pointed mandibles, the maxillæ, and labium. Just dorsal to, and at the base of, the mandibles are the irregular pigmented eye spots. Nine spiracles are present, the first pair being of large size and brown color and situated back of the head on the second thoracic segment. All the other spiracles are indistinct. The body still retains the U shape, though now the anal extremity reaches only as far as the first or second thoracic segments. If the mature larva is hairy as in the case of *Aphelopus* species,

the hairs can be seen resting back along the body, those of the
first segment pointing cephalad, those of the rest caudad.   In
some species the peculiar cone-like structure is still present
in this stage.   This is evidently peculiar to only those species
ovipositing in the abdomen of the host and it is characteristic
of at least four stages since in nearly mature larvæ a series of
four, all telescoping more or less within each other, can be
seen.   It has been found in parasites ovipositing in the abdomen
of *Chlorotettix unicolor* nymphs, *Deltocephalus inimicus* nymphs
and adults, and *Deltocephalus sayi* adults.

While in the sac the head of the dryinid larva is always
ventral and the caudal end of the body is curved upwards and
anteriorly lying dorsal to it.   The spiracles of all the exuviæ
are open, but are not connected in any way with those of any
of the larval spiracles.   However, a trachea can be seen running
from the first spiracle of the third exuvium to the corresponding
spiracle of the larva itself, so that it is possible some air may be
taken in by the parasite in this way.   The fifth instar is enclosed
laterally by the three exuviæ and dorsally by the third only.

Mature Larva.—The mature larvæ vary in size, those studied
measuring from 1.5 mm. to 4 mm. in length.   They are blunt
and wider posteriorly and more pointed anteriorly (Fig. 16).
They are variously colored, agreeing in many cases with the
color of their hosts.   They may be various shades of green and
even light pink, but as a rule they are white.   *Aphelopus* larvæ
are quite pubescent, but those of the more highly specialized
types are almost without hairs.   The head is distinctly separated
from the body and is light brown or grey in color.   Thirteen
segments are visible not including the head.   They are more or
less concealed by the folds in the skin.   On the head (Figs.
17 and 18) dorsally the two black pigmented eyes, the rudi-
mentary antennæ and the short arcuate labrum are visible.
The former may be but slightly pigmented and very indistinct,
even in a species that normally has pigmented eyes.   The
labrum is covered with short spines and appears as a fleshy
projection from the side.   The curved heavy mandibles are
very prominent.   They are one-jointed and articulated from
a chitinized basal piece.   In *Neodryinus* and *Paradryinus* the
cutting edge is crenulate or denticulate (Perkins, 1905), or it
may be notched in *Gonatopus* (Mik, 1880).   The maxillæ are
less distinct.   Laterally they are represented as short truncate

fleshy lobes from which project the short one-jointed maxillary palpi.   The latter bear at their ends two minute papillæ, each with a spine at the tip.   The labium is large and very prominent. From the side it is seen as a fleshy elongated process with a distinct apical half cut off from a broader basal piece.   The basal piece or sub-mentum of the labium extends nearly back to the posterior margin of the head.   To it is attached the mentum which extends just beyond the tips of the mandibles and bears at its tip a semi-circular transparent organ.   A narrow tri-angular piece is attached about half way back on the ventral side of the mentum and projects to the tip of the labium. It is the spinneret and at either side of this the small one-jointed labial palpi are attached.

The pair of thoracic spiracles are nearly concealed under a fold in the integument and the others are very small and usually not visible.   All the abdominal segments except the last two bear a pair of spiracles, there being ten pairs in all.

PREPUPA.—After spinning the cocoon the larva soon becomes quiescent and shrinks down into the lower half of it.   Within a few days it becomes straight, rigid, extending the length of the cocoon, and constricted near the middle.   After assuming this position it soon pupates.

PUPA.—The pupa (Figs. 19 and 20) is white, all the parts of the adult insect being plainly distinguished.   If the adult is winged the wing pads are large and extend the length of the thorax to the first abdominal segment.   Seven abdominal segments are visible.   Pigmentation begins in the compound eyes and gradually spreads over the entire body the pupa becoming black before the adult issues.

LARVAL SAC.—As previously stated the larval sac is merely the cast skins of the larva itself modified for protective purposes by being more or less chitinized, and firmly attached to each other and to the host.   The means of anchoring the sac to the host varies in different genera.   In *Aphelopus* this attachment consists of a sort of chitinous ring and two hooks, (Figs. 21 and 22).   One of the latter is smaller, sharply pointed, and strongly chitinized, the other is larger, blunt and but thinly chitinized. The chitinous ring serves to keep the cuticula of the host open, thus affording a place for the head and mandibles of the parasite.
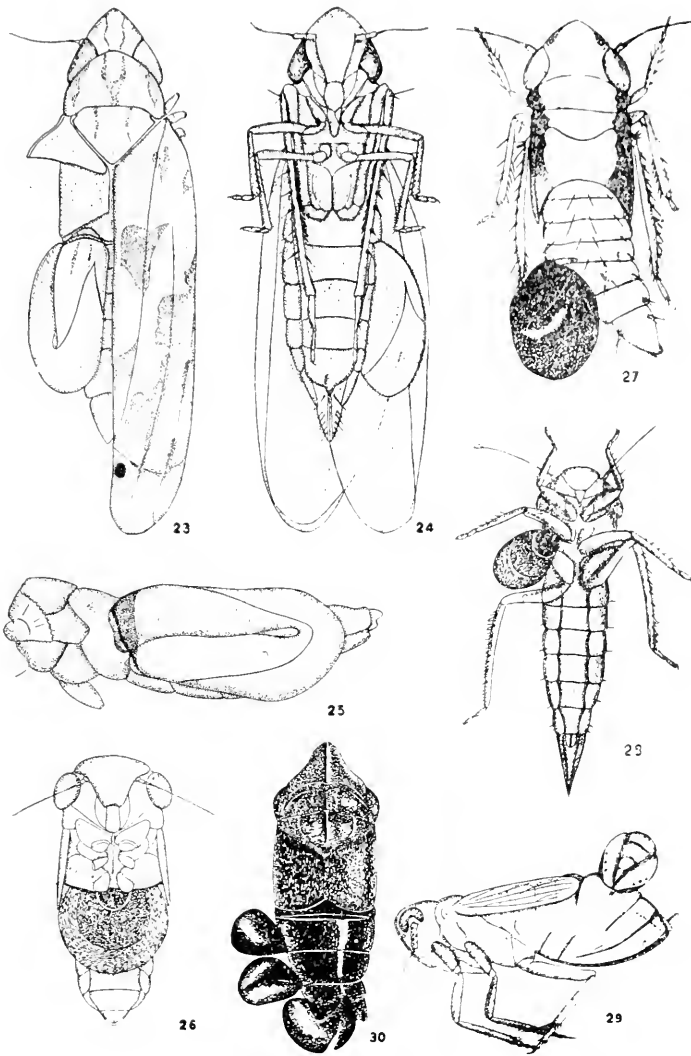
FIGURE 3.

23-25, dorsal, ventral and side views of *Erythroneura comes* parasitized by *Aphelopus* sp.; 26, ventral view of *Agallia sanguinolenta* parasitized by *Anteon* sp.; 27, dorsal view of *Deltocephalus inimicus* nymph parasitized by *Gonatopus erythrodes;* 28, ventral view of *Chlorotettix unicolor* nymph parasitized by *Chelogynus* sp.; 29, side view of *Liburnia campestris* adult parasitized by *Haplogonatopus americanus;* 30, dorsal view of *Brucomorpha oculatus* parasitized by *Phorbas mirabilis.*

The sac itself is of various shapes, sizes and colors. Those of *Aphelopus* (Figs. 23, 24 and 25) are elongate oval, and those of *Chelogynus* are rounded and much compressed. Between these two types there are all sorts of gradations. Black is the predominating color and there are variations from it to brown and yellow. Many are green or blue-green, and others are banded transversely with alternate stripes of light and dark brown. In the latter case the colors are arranged segmentally. When the skin that is to form part of the sac is molted it is light colored and not pigmented and modified. As it becomes exposed to the air it assumes the black or fuscous color of the sac. In *Phorbas* the exuvium is pale yellow when first molted, but soon each spiracle is surrounded by a black spot. As previously noted, these enlarge and become confluent, the exuvium finally becoming jet black in color. Invariably the first exuvium is smooth and shining, the second often crinkled or sculptured on its outer margin, and the third is generally very distinctly rugosely sculptured by raised zig-zag lines or is punctate. The sac is located in diverse positions, according to the genus of the parasite. In *Echthrodelphax, Paradryinus, Thaumatodryinus* and *Neodryinus* it is found on the thorax beneath the wing. In *Phorbas* (Fig. 26), from various places on the abdomen. In most of the *Anteon* species (Fig. 30), on the ventral side under the hind legs, in *Paranteon* on the abdomen, ventral as well as dorsal, seldom on the sternum or propleura, in *Pseudogonatopus* on the dorsal and lateral sides of the abdomen, in *P. stenocrani* Perk., upright between both wings (Perkins, 1905). In *Gonatopus* (Fig. 27) it is on the side of the abdomen, in *Haplogonatopus* (Fig. 28), on the dorsal posterior part of the abdomen, in *Chelogynus*, (Fig. 29), on the side of the thorax, and in *Aphelopus* on the sides of the abdomen between the first few segments. It always projects between two segments. Often the spiracles of the different exuviæ composing the sac can be seen if it is light colored.

Cocoon.—The cocoon is either spun below the ground as is the case with *Aphelopus, Chelogynus,* or *Phorbas,* or above on some convenient object, as with *Haplogonatopus,* or some species in *Gonatopus.* That of *Aphelopus,* (Fig. 31), is small, oval, and white, of *Chelogynus,* (Fig. 33), larger, oval, plastered over with sand grains or soil particles, and that of *Bocchus,* (Fig. 32), tough, thick, brown and fibrous, with soil particles

mixed all through it.   Many spun above the ground as in some
species in *Gonatopus*, (Fig. 34), are white, shining, and very
like a spider's cocoon.   According to Perkins (1905) the cocoons
of *Paradyinus* are often adorned with bits of leaf tissue, that of
Neodryinus roofed over with the ruptured larval sac which is
removed from the hopper and attached.   The cocoon of *Pro-
dryinus ormenidis* (Ashm.) is spun beneath the dead hopper
(Swezey, 1903).   The cocoon is always composed of two parts,
and inner more compact structure, within a more loosely woven
part.
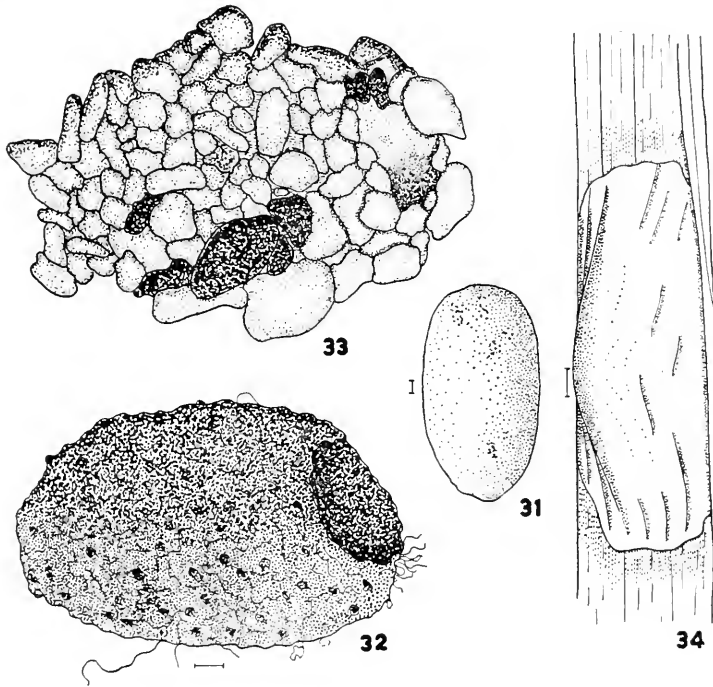
FIGURE 4.

31, cocoon of *Aphelopus* sp., 32, cocoon of *Phorbas mirabilis*; 33, cocoon of
Chelogynus sp.; 34, cocoon of *Haplogonatopus americanus*.

INTERNAL ANATOMY OF THE LARVA.

Internally the mature larva presents the following char-
acteristics.   The mouth leads into a narrow pharynx-
esophagus the limits of either of the latter not being definable.
This opens into a very large, thick-walled mid-intestine, which
is blind at its posterior end, not being connected with the hind-

intestine, which, however, is present at this stage. The pharynx-esophagus is long, extending back to the hind thoracic segment. It is very narrow with a small lumen for the greater part of its length, but broadens out gradually at first, then abruptly, into the mid-intestine. The latter occupies the greater part of the body cavity and becomes greatly distended at maturity, food being taken in much more rapidly than it can be digested, so that the entire mid-intestine acts as a food reservoir.

A set of powerful muscles is attached to the dorsal part of the pharynx-esophagus and a smaller set below it. These act in such a way that their contraction forces this structure open, thus forming a sucking organ. Aside from these the only other striped muscles in the larva of note are those controlling the mandibles. The cells of the pharynx-esophagus are small. Those of the anterior fourth of the mid-intestine are large, columnar, and digestive in function, in contrast to those of the greater part, which are elongate and flattened.

The salivary glands are very large, appearing as two sets of long convoluted tubes, one on each side of the mid-intestine, extending about three-fourths the way down it in the mature larva. Each set is composed of two branches ending anteriorly in a short lateral tube. These two lateral branches open into a common duct which extends into the spinneret. They serve primarily as silk glands in the spinning of the cocoon. The cells composing the main duct are columnar, thus differing distinctly from those of the rest of the glands. Undoubtedly the true salivary function is principally confined to this section of the glands.

There is no caudal vesicle on the larva as observed for Apanteles (Tower, 1916), and no malpighian tubes have been observed in any of the stages. Whether the waste products are absorbed and discharged upon pupation, or whether they are thrown off into the host is not known. The ten pairs of spiracles lead into short lateral tracheæ which open into the two longitudinal trunks, the tracheal system in the mature larva being very similar to the general type found. As in the third instar the nervous chain consists of eleven ganglia.

THE COMMON RAVENS OF NORTH AMERICA.

By Harry C. Oberholser.

The subspecies of the common raven, *Corvus corax* Linnaeus, are among the most difficult birds of the family Corvidae. The differences characterizing them are almost wholly those of size and proportion; and because great individual variation complicates the case, these are largely average distinctions and require series of specimens for proper elucidation. In the Old World some 16 or 17 forms are at present recognized,[1] but in North America currently only two, *Corvus corax principalis* of northern North America, with which the birds of the eastern United States are considered identical, and *Corvus corax sinuatus* of the western United States and Mexico. Another, however, has been recently described by Doctors Rothschild and Hartert as *Corvus corax clarionensis*,[2] from Clarion Island, in the Revilla-gigedo group, western Mexico, and it is now proposed to separate the bird from the eastern United States as a fourth race. By the recognition of these two additional subspecies, the measurements, characters, and distribution of the two original forms are in need of considerable readjustment, and they are, therefore, included in the discussion that follows.

The material used in the present study consists of about 400 specimens. This represents the collections of the United States National Museum, including the Biological Survey; the Academy of Natural Sciences of Philadelphia; the Museum of Comparative Zoölogy at Cambridge, Massachusetts; the American Museum of Natural History; the Brooklyn Museum of Arts and Sciences; Dr. Louis B. Bishop, Dr. Jonathan Dwight, Dr. L. C. Sanford, Dr. Witmer Stone; Messrs. William Brewster, John E. Thayer, A. C. Bent, and E. A. and O. Bangs. To the authorities of these museums and to the individuals here mentioned the writer is indebted for placing their specimens at his disposal.

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[1]For an excellent account of the Old World forms of *Corvus corax*, cf. Hartert, Vögel paläarkt. Fauna, Heft 1, November, 1903, pp. 2–8; Heft VI, June, 1910, pp. XIII–XIV.

[2]Novit. Zool., IX, No. 2, July 25, 1902, p. 381.

All the measurements in this paper are in millimeters, and have been taken as described in the author's paper on *Butorides virescens*.[1]

CORVUS CORAX PRINCIPALIS Ridgway.

C[orvus]. *corax principalis* RIDGWAY, Man. North Amer. Birds, 1887, p. 361 ("Northern North America, from Greenland to Alaska, south to British Columbia, Canada, New Brunswick, etc.").

Corvus corax var. *littoralis* HOLBOELL, in Kroyer's Tidskrift, IV, 1843, p. 390 (Greenland; Labrador) (nec *Corvus littoralis* Brehm).

Chars. subsp.—Size largest of the North American races.

Measurements.[2]—Male:[3] wing, 426-457 (average, 446.5) mm.; tail, 241-259 (250); exposed culmen, 67-76 (71.3); height of bill at nostrils, 26-30 (27.7); tarsus, 66-71 (69); middle toe without claw, 45.5-54 (49).

Female:[4] wing, 413-441 (average, 426) mm.; tail, 228.5-246.5 (250); exposed culmen, 68-72 (70.4); height of bill at nostrils, 25-27.5 (26.1); tarsus, 64-70 (66.5); middle toe without claw, 43.5-48 (45.5).

Type locality.—Saint Michael, Alaska.

Geographic distribution.—Northern North America. Breeds North to northern Greenland, Grant Land, Melville Island, Banks Land, Herschell Island, and the northern coast of Alaska; west to the western coast of Alaska, the Aleutian Islands, and Vancouver Island, British Columbia; south in the Pacific coast region to Quinault, western Washington, and in the interior to northern Mackenzie and northern Quebec (Ungava); and east to northeastern Quebec (Ungava), and Greenland.

Remarks.—This North American race is distinguished from *Corvus corax corax* Linneaus of northern Europe by its relatively

[1] Proc. U. S. Nat. Mus., XLII, 1912, p. 533.

[2] In part taken by Mr. Robert Ridgway; but the measurements of exposed culmen in the Bulletin of the United States National Museum, No. 50, part III, 1904, p. 259, are really those of the *total* culmen, given by mistake as exposed culmen; and there is evidently also some mistake in the height of the bill at nostrils, as this appears to be too large. Both these dimensions have, therefore, been remeasured for the present use.

[3] Six specimens, from Alaska.

[4] Eight specimens, from Alaska.

shorter and higher bill, less lustrous plumage, and less developed and more purplish-hued lanceolate feathers of the throat; and from *Corvus corax behringianus* Dybowski by the long third primary, which equals or is longer than the fifth, instead of being decidedly shorter.   As has already been intimated, the characters which distinguish this from the other North American forms are wholly of size and proportions.   The greatest differentiation occurs in Alaska, whence came the type of *Corvus corax principalis;* hence we have here used only Alaskan specimens in the comparison of racial characters. Birds from Greenland and northern Ungava are somewhat smaller than those from Alaska, but are most satisfactorily referred to this form.   Examples from the western coast of British Columbia are also intermediate between the present race and *Corvus corax sinuatus;* those from western Washington are still smaller, and, indeed, almost half-way between *Corvus corax principalis* and *Corvus corax clarionensis;* but birds from both these regions are better referred to the present form than to either of the others.   This applies, however, only to the coast region, since the interior birds are decidedly nearer the southern races, as elsewhere more fully explained.   By the segregation of the birds from the eastern United States and by the extension of the range of *Corvus corax sinuatus* into the middle portion of Canada, the range of *Corvus corax principalis* becomes limited to the extreme northern parts of North America, excepting, as above stated, on the Pacific Coast, where it reaches southward in a relatively narrow coastal strip as far as the State of Washington.

CORVUS CORAX EUROPHILUS, subsp. nov.

Chars. subsp.—Similar to *Corvus corax principalis*, but smaller, with a relatively larger bill.

Description.—Type, adult male, No. 260039, U. S. Nat. Mus., Biological Survey collection; Ardell, Alabama, April 4, 1915; L. J. Goldman; original number, 211.   Entire plumage glossy black, the secondaries and inner primaries somewhat brownish, the head, back, rump, upper tail-coverts, and breast with a slightly bluish sheen, the throat and wings with purplish reflections; bill and feet black.

MEASUREMENTS OF SPECIMENS OF Corvus corax europhilus.

Museum and number	Sex	Locality	Date	Collector	Wing	Tail	Exposed culmen	Height of bill at nostrils	Height of bill at base	Tarsus	Middle toe without claw
A.N.S.Phila. 3295.1 A.N.S.Phila.	♂	New Jersey	Jan. —, 1806	J. Cassin	420	237	65	25.5	28	64.5	44
31611 U.S.N.M. 208190	♂	Craig Co., Va.	Feb. —, 1910	J. Rouble	417	238	76	28	30	73.5	46.5
	♂	Young Harris, Ga.	Jan. 25, 1888	W. Jenkins	432	241	64[1]	25.5[1]	26.5	66	51
W.Brewster, 28867	♂	Clinton Co., Pa.	Oct. 29, 1889	W.E.D.Scott	435	254	72[1]	26	27	74	48
W.Brewster, 28866	♂	Asheville, N.C.	Oct. 24, 1889	W.E.D.Scott	433	256	70	26.5	28	69	46.5
U.S.N.M., 259039	♂	Asheville, N.C.	April 4, 1915	L. J.Goldman	425	230	76	27	31	72	46
W.Brewster, 17521	♂	Ardell, Ala.[2]	Mar. 8, 1897	G. F. Dippie	436	240	70	26.5	29	69	45
M.C.Z., 13901	♂	Loring, Ontario	Mar. 1, 1891	W. S. Bryant	450	262	73	27	28	68	47
M.C.Z., 11118	♂	Eastport, N. Scotia		O. Bryant	437	246	71	27.5	28	73	49
W.Brewster, 1191B	♂	St. Anthony, Newfoundland	Mar. 10, —	H.W.Henshaw	421	211	70	26	27.5	66	44
A.M.N.H., 35702	♂	Eastport, N.Y.	Dec. 25, 1886	J.Richardson	409	231	72	27.5	28.5	67	45
W.Brewster, 18268	♂	Eastport, Me.	Oct. 13, 1898	A. G. Dorr	432	256	72.5	27.5	29	65	45
W.Brewster, 10151	♂	Swans Island, Maine	Feb. 15, 1885	M.A.Frazar	429	246	68	27	28	70	44
W.Brewster, 10153	♂	Isle au Haut, Maine	Jan. 3, 1886	W. Brewster	418	240	70	27.5	28	73	48
W.Brewster, 13549	♂	Bar Harbor, Mt. Desert I., Maine	Feb. 4, 1885	E. S. Bowler	436	242	70	28	28	68	45
W.Brewster, 16468	♂	Hsford, Maine Horsehead Island	April 15, 1897	A. G. Dorr	447	247	71	30		70	45
E.A.& O. Bangs, 65	♂	Penobscot Bay, Me. Nantucket, Grand Manan Island, N.B.	Mar. 15, 1877	R. Thaxter	380		72.5	28	28.5	72	48.5
L.B.Bishop, 27885	♂	Marshall Co., Minn.	Dec. 2, 1889	E. L. Brown	413	246	67	27	28.5	69	43.5
A.C.Bent, 2109	♂	Aitkin, Minn.	Feb. 20, 1889	A. Lano	405	230	66	26	28	67	43
W.Brewster, 17522	♀	Loring, Ont.	Mar. 8, 1896	G. F. Dippie	425	245	70	26.5	27	68.5	43
M.C.Z., 13902	♀	Eastport, N. Scotia	Mar. 1, 1891	W. S. Bryant	407	224	67.5	25	26	66.5	44.5

[1]Used in measurement averages on page 218.
[2]Type.

MEASUREMENTS OF SPECIMENS OF *Corvus corax euophilus*—Continued.

Museum and number	Sex	Locality	Date	Collector	Wing	Tail	Exposed culmen	Height of bill at nostrils	Height of bill at base	Tarsus	Middle toe without claw
W.Brewster, 1911	♂	Eastport, N. Y.	Mar. 10, —	H.W.Henshaw	405	244	65	25	25.5	63	43
W.Brewster, 13511	♂	Bechoine, Quebec	Sept. 3, 1881	M.A.Frazar	411	232	65.5	24	25.5	66	42
E. A. & O. Bangs, 4112	♂	Lance au Loup, Labrador									
W.Brewster, 17903	♂	Deer Island, Penobscot Bay, Me.	May 26, 1899	E. Doane	432	240	71	29	30	70	45.5
W.Brewster, 9927	♂	Isle au Haut, Me.	Spring, 1897	C. L. Knight	404	230	65.5	25	26	67	43
W.Brewster, 10152	♂	Isle au Haut, Me.	Mar. 10, 1889	S. W. Denton	446	243	67	27.5	28	65	46
W.Brewster, 16169	♂	Horsehead Island, Penobscot Bay, Me.	Feb. 15, 1885	M. A. Frazar	431	231	61	27.5	28	67	42
W.Brewster, 18267	♂	Horsehead Island, Penobscot Bay, Me.	April 15, 1897	A. G. Dorr	442	244	68.5	27.5	28	65	43
W.Brewster, 19970	♂	Penobscot Bay, Me.	April 11, 1898	A. S. Dorr	407	229	71	24	25	64	44
A. N. S. Phila., 62577	♂	Ontanagon, Mich.	Oct. 8, 1881	A. J. Dayan	410	234	67	25	26	63	46
W.Brewster, 28869	♂	West Creek, N. J.	Feb. 16, 1897	O. Crammer	418	244	64.5	24	25.5	70	41
W.Brewster, 28868	♂	Clinton Co., Pa	Jan. 25, 1888	W.E.D.Scott	407	241	67.5	21	25.5	61	38.5
State Mus. N. C.	♂	Asheville, N. C.	Oct. 29, 1889	W.E.D.Scott	399	227	66	25	25.5	65	43
A.M.N.H., 55383		Asheville, N. C.	Oct. 29, 1889	A. D. Mills	422	243			26	65	42
A.N.S.Phila., 3311		Topton, N. C.		L.M.Loomis	410	237			27	65	43
M.C.Z., 17739		Near Mt. Pinnacle, Pickens Co., S. C.	Jan. 27, 1889	J. Cassin	406	237	68	27	27.5	68	48.5
W.Brewster, 391		New Jersey		J. Cassin	440	262	71	26	25.5	73	46
U.S.N.M., 18831		Smith's Landing, N.J.	Nov. —, 1852	W. Perhan	397	241	65	26	28	64	43.5
		Tyngsboro, Mass.	Oct. —, 1860	C. Drexler	431	255	73	27	28	71	43
		Lake Abitibi, Ont.			430	246	69	27.5		68	43
W.Brewster, 18510		Deer Isle, Penobscot Bay, Me.	Spring, 1887	C. L. Knight	430	249	71	29.5	30	71.5	47

[1] Used in measurement averages on page 218.

Measurements.—Male:[1] wing, 417-435 (average, 427) mm.; tail, 230-256 (242.7); exposed culmen, 64-76 (70.5); height of bill at nostrils, 25.5-28.4 (26.6); tarsus, 64.5-74 (69.8); middle toe without claw, 44-51 (46.7).

Female:[2] wing, 399-422 (average, 411.5) mm.; tail, 227-244 (238.8); exposed culmen, 64.5-67.5 (66.3); height of bill at nostrils, 24-25 (24.5); tarsus, 64-70 (66); middle toe without claw, 38.5-43 (41.1).

Type locality.—Ardell, Cullman County, north central Alabama.

Geographic distribution.—Eastern United States and southeastern Canada. Breeds north to Lance au Loup, southern Labrador; central Quebec; and Lake Abitibi, central Ontario; west to Marshall County, Minnesota; and Copeland, western Arkansas; south to Copeland and Newport, northern Arkansas; Nashville, central Tennessee; Ardell, north central Alabama; Chattanooga, southeastern Tennessee; Young Harris and Toccoa, northeastern Georgia; and Mount Pinnacle and Caesar's Head, northwestern South Carolina; east to northwestern South Carolina; Tryon and Grandfather Mountain, western North Carolina; Cobbs Island, eastern Virginia; Tuckerton, eastern New Jersey; Commack Hill, Long Island, New York;[2] South Manchester, central Connecticut;[2] Tyngsboro, eastern Massachusetts;[3] Bar Harbor, southeastern Maine; Grand Manan Island, southwestern New Brunswick; Eastport, Nova Scotia; and St. Johns, eastern Newfoundland.

Remarks.—The status of the ravens inhabiting the eastern United States has long been doubtful. The fairly good series of specimens now available shows that the birds from this region are apparently best treated as a separate subspecies. They are, to be sure, to a certain extent intermediate between *Corvus corax principalis* and *Corvus corax sinuatus;* and, furthermore, from either of these two races are separated by only average characters, but the same thing is true of all the other races. In the measurement averages here given, only specimens from Pennsylvania and New Jersey southward to Alabama are included, and these together are considered typical. Examples from New York, New England, central

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[1] Seven specimens, from Alabama, Georgia, North Carolina, Virginia, Pennsylvania, and New Jersey.
[2] Four specimens, from North Carolina, New Jersey, and Pennsylvania.
[3] Not breeding.

Ontario, Nova Scotia, New Brunswick, Newfoundland, and even the southern Labrador coast are intermediate between the bird from the southern Allegheny Mountains and *Corvus corax principalis*, but seem to be decidedly nearer the southern form.   Those from Michigan and Minnesota are in like manner intermediate, but verge also somewhat toward *Corvus corax sinuatus*, though they average nearer *Corvus corax europhilus*.

There is apparently no name available for this race, as *Corvus carnivorus* Baird,[1] adopted from Bartram, is clearly a synonym of *Corvus corax sinuatus*, as explained under that race.[2]

Detailed measurements of specimens are given in the table on pages 216–217.

Corvus corax sinuatus Wagler.

C[orvus]. *sinuatus* WAGLER, Isis, 1829, p. 748 (Mexico) (ex Lichtenstein MS.).

Corvus corax sinatus RIDGWAY, Ornith. Ill., I, 1889, p. 331 (err. typ. pro *Corvus sinuatus* Wagler).

Corvus Cacalotl WAGLER, Isis, 1831, p. 527 (Mexico).

Corvus catototl BONAPARTE, Geog. & Comp. List Birds Eur. and N. Amer., 1838, p. 28 (southern parts of North America.)

Corvus major WÜRTUMBURG, Erste Reise in Nordl. Amer., 1835, p. 294 (Nebraska) (nomen nudum).

Corvus major RIDGWAY, Bull. U. S. Nat. Mus., No. 50, III, Dec. 31, 1904, p. 263 (nom. nov. pro *Corvus sinuatus* Wagler [in synonymy]).

Corvus nobilis GOULD, Proc. Zool. Soc. Lond., V, 1837, (Dec. 5, 1837) p. 79 (Mexico).

C[orvus]. *splendens* BONAPARTE, Proc. Zool. Soc. Lond., 1837 (June 14, 1838), p. 115 (nomen nudum, but probably a lapsus calami for *Corvus nobilis* Gould).

C[orvus]. *lugubris* AGASSIZ, Proc. Bost. Soc. Nat. Hist., II, 1846, p. 188 (nomen nudum).

Corvus carnivorus BAIRD, Rep. Explor. & Surv. R. R. Pac., IX, 1858, p. 560 (Fort Randall, South Dakota).

Corvus lugubris BAIRD, Rep. Explor. & Surv. R. R. Pac., IX, 1858, p. 560 (in synonymy), p. 561 (in text) (nom. nov. pro *Corvus carnivorus* Baird).

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[1] Rep. Explor. & Surv. R. R. Pac., IX, 1858, p. 560.
[2] *Cf. postea*, p. 221.

Chars. subsp.—Similar to *Corvus corax europhilus*, but wing and middle toe shorter, and bill decidedly smaller.

Measurements.[1]—Male:[2] wing, 415.5-459.5 (average, 434) mm.; tail, 223-254 (239); exposed culmen, 64-70 (66.8); height of bill at nostrils, 23-26 (24.4); tarsus, 68-73 (71.5); middle toe without claw, 41-56 (46.5).

Female:[3] wing, 419-432 (average, 422) mm.; tail, 236-252 (246.5); exposed culmen, 63-71 (66.3); height of bill at nostrils, 24-25 (24.5); tarsus, 65-73.5 (70); middle toe without claw, 44.5-47 (46.5).

Type locality.—Orizaba, Vera Cruz, Mexico.[4]

Geographic distribution.—Middle western Canada, middle western United States, and Mexico, to Honduras. Breeds north to Slave River and Fort Simpson, southwestern Mackenzie; west to Sicamous, Shuswap, and Okanagan, central southern British Columbia; northeastern Washington (probably); Fort Sherman, Idaho; western Wyoming; western Colorado; Fort Wingate, western New Mexico; San Luis Mountains, Mexican Boundary Line, southwestern New Mexico; San Pedro River, at the Mexican Boundary Line, southeastern Arizona; Quitovaquita, southwestern Arizona; Guaysmas, western Sonora; Mazatlan, western Sinaloa; and Tepic; south to Tehuantepec, Oaxaca; Guatemala; and northern Honduras; east to northern Honduras; Vera Cruz, Mexico; San Antonio, central Texas; the Canadian River, central Oklahoma; Fort Riley, eastern Kansas; Fort Randall, central southern South Dakota; and Ramsey County, central northern North Dakota.

Remarks.—Compared with *Corvus corax principalis*, this race is smaller, with a particularly small bill, which is relatively as well as actually more slender. As will be noticed in the geographic distribution above given, the range of this form has been restricted in southwestern North America by the recognition of *Corvus corax clarionensis* as a bird of the mainland as well as the islands off the southwestern coast; and extended by the inclusion of a large area in middle Canada, the birds inhabiting which are much nearer this southern race than to

[1] *Cf.* footnote on p. 214, under *Corvus corax principalis*.
[2] Nine specimens, from Guatemala, central and southern Mexico.
[3] Five specimens from Guatemala, central and southern Mexico.
[4] Here for the first time definitely fixed.

Corvus corax principalis. Birds from central southern British Columbia are clearly the present form; in fact, specimens examined are practically typical, as indeed also are the few seen from southwestern Mackenzie. There is not yet sufficient material available to determine the northeastern limits of the range of *Corvus corax sinuatus* in Manitoba. Although no specimens have been examined from the northeastern part of the State of Washington, the raven inhabiting that region belongs probably to the present race.

This western raven was originally described by Wagler[1] from a specimen taken in Mexico. In view of the multiplication of races in North America, and since the specimen on which Wagler's name was based probably came from eastern Mexico, we hereby designate Orizaba, Vera Cruz, Mexico, as the type locality. Concerning none of the other synonyms above cited in the synonymy of *Corvus corax sinuatus* is there any question, excepting perhaps *Corvus carnivorus* Baird.[2] This is a composite name, adopted from Bartram, whose specific names, of being non-binomial, are unacceptable; and the status of course, this one must be determined, therefore, solely by the use made of it by Baird, since he first gave it nomenclatural status. His account[3] includes all four of the North American races here recognized, all of which he considers as belonging to a single form, and which he called the "common North American raven." The name *Corvus carnivorus* is certainly unavailable for the bird from the eastern United States, since Baird's text was evidently all written before he had seen a specimen of that form, and his characters were undoubtedly drawn entirely from western birds. The only specimen of the eastern raven that he was able to see at all was a specimen from New Jersey, and notice of that he subsequently inserted in a footnote.[4] It is also indicated by his text that neither can the name be legitimately used for *Corvus corax principalis* Ridgway, a view evidently taken by Mr. Ridgway in describing the latter subspecies. Since most of Baird's specimens are referable to the bird now called *Corvus corax sinuatus*, which is the commonest and best known North American form, it seems most logical

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[1] *Corvus sinuatus* Wagler, Isis, 1829, p. 748.
[2] Rep. Explor. & Surv. R. R. Pac., IX, 1858, p. 560.
[3] *Loc. cit.*
[4] *Loc. cit.*, p. 561.

MEASUREMENTS OF SPECIMENS OF *Corvus Corax clarionensis*

Museum and number	Sex	Locality	Date	Collector	Wing	Tail	Exposed culmen	Height of bill at nostrils	Height of bill at base	Tarsus	Middle toe without claw
A.M.N.H. 131669[1]	♂	Cerros Island, Lower California, San Benedicto	Mar. 12, 1911	H.E.Anthony, C.H.Townsend	421	228	65	25	26.5	69.5	43
U.S.N.M. 117507	♂	San Benedicto Island, Mexico	Mar. 10, 1889	C.H.Townsend	395	213	63	24	...	65	46.5
U.S.N.M. 139171[1]	♂	Santa Catalina Island, California	April 26, 1892	C.P.Streator	412	225	64.5	24	...	64.5	46
A.B.Howell[2]	♂	Santa Catalina Island, California[2]	Feb. 17, 1910	...	365	216	65	...	...	69	42
A.M.N.H. 131671[1]	♂	Abreojos Point, Lower California	Mar. 16, 1911	H.E.Anthony, C.H.Townsend	412	231	66.5	25	26	73	43
A.M.N.H. 131670[1]	♂	Abreojos Point, Lower California	Mar. 16, 1911	P.I.Osburn, C.H.Townsend	383	202	67	24	26.5	69.5	44
U.S.N.M. 139161	♂	Pahrump Valley, California	Feb. 24, 1891	A.K.Fisher	421	230	64	24	...	69	47
U.S.N.M. 83910	♂	Glendale, Nev.	Nov. 18, 1867	R.Ridgway	413	243	65	23	...	70	43.5
U.S.N.M. ——	♂	Narrows, Oregon	June 8, 1917	G.G.Cantwell	410	230	63	22.5	...	63	45
E.A.& Co., Bangs, 15963[2]	♀	Cerros Island, Lower California	April 5, 1906	...	395	219	63	23.5	25	67	41
A.C.Bent, 3349[1]	♀	Santa Cruz Island, California	Dec. 7, 1907	C.B.Linton	379	218	63	22	23.5	66	42.5
A.C.Bent, 3348[1]	♀	Santa Cruz Island, California	Dec. 4, 1907	C.B.Linton	408	235	63.5	23.5	25.5	68	43
L.B.Bishop, 18517[1]	♀	San Clemente Island, California	Mar. 15, 1907	C.B.Linton	387	220	59	23	24.5	67.5	41
L.B.Bishop, 18516[1]	♀	San Clemente Island, California	Jan. 21, 1907	C.B.Linton	395	218	62	23.5	25	68.5	40
J.Dwight, 20177[1]	♀	San Clemente Island, California	Jan. 23, 1907	C.B.Linton	396	222	63	22.5	23.5	67	40.5
U.S.N.M. 117508[1]	♀	San Benedicto Island, Mexico	Mar. 10, 1889	C.H.Townsend	412	229	61	23.5	...	66	47.5

[1]Used in measurement averages on p. 224.
[2]Measured by Mr. A. B. Howell.

MEASUREMENTS OF SPECIMENS OF *Corvus Corax clarionensis*—Continued

Museum and number	Sex	Locality	Date	Collector	Wing	Tail	Exposed culmen	Height of bill at nostrils	Height of bill at base	Tarsus	Middle toe without claw
U.S.N.M. 117509	♀	San Benedicto Island, Mexico	Mar. 10, 1889	C.H. Townsend	390	215	61	23		63	39
U.S.N.M. 135459	♀	San Clemente Island, California	Aug. 28, 1894	E. A. Mearns	402	219	58	21.5		66	45
U.S.N.M. 135458	♀	San Clemente Island, California	Aug. 25, 1894	E. A. Mearns	379	207	58	21.5		67.5	40
U.S.N.M. 135457	♀	San Clemente Island, California	Aug. 25, 1894	E. A. Mearns	383	215	57	21.5		64	45.5
A. B. Howell[2]	♀	Santa Catalina Island, California[2]	May 25, 1908		371	217	65			67	42
A. B. Howell[2]	♀	Santa Catalina Island, California[2]	Feb. 11, 1910	H.E.Anthony,	370	210	68			70	46
A.M.N.H. 131672[1]	♀	San Bartolome, Lower California	Mar. 11, 1911	C.H.Townsend	387	216	61.5	24.5	25.5	69	39
U.S.N.M. 86131[1]	♀	Porto Borlandra, near La Paz, Lower California	Feb. 4, 1882	L. Belding	385	224	64	23		64.5	41.5
U.S.N.M. 203825[1]	♀	Santa Anita, Lower California	Jan. 12, 1906	E. W. Nelson, E. A. Goldman	383	216	60	21.5		65	42
U.S.N.M. 139463	♀	Lone Willow Spring, California	Jan. 11, 1891	E. W. Nelson	406	220	61.5	22		64	41
U.S.N.M. 1839 B	♂	Warren's Well, California	May 16, 1902	F. Stephens	370	208	56.5	21		61.5	38
U.S.N.M. 139467	♂	Pahrump Valley, Nevada	Feb. 21, 1891	A. K. Fisher	397	218	60	22.5		66	42.5
U.S.N.M. 12920	♂	Wells, Nevada	Oct. 18, 1890	V. Bailey	396	232	61	22.5		64	41
U.S.N.M. 139470	♂	Ft. Tejon, Cal.		J. Xantus	410	233	62	22.5		66	42
U.S.N.M. 107113	♀	Umatilla, Oregon	Oct. 17, 1890	C.P. Streator	397	228	60.5	24		67	42
U.S.N.M. 6857		Humboldt Bay, Cal	Dec. 7, 1885	C.H. Townsend	377	218	59.5	24		64	42
		San Rafael River, Utah		E. G. Beckwith	407	225	60	22		66	41

[1] Used in measurement averages on p. 221.
[2] Measured by Mr. A. B. Howell.

to restrict Baird's *Corvus carnivorus* to this race rather than to *Corvus corax clarionensis* from the southwest, specimens of which formed a part of the material available to Professor Baird. Since the specimen best agreeing with his description, and the one with which he made his chief comparisons is No. 5186, U. S. Nat. Mus., an adult male, from Fort Randall, South Dakota, taken, October 18, 1856, it seems proper to consider this the type, and Fort Randall, South Dakota, therefore, the type locality.   The name, of course, thus becomes a synonym of *Corvus corax sinuatus* Wagler.

Corvus corax clarionensis Rothschild and Hartert.

Corvus corax clarionensis ROTHSCHILD and HARTERT, Novit. Zool., IX, No. 2, July 25, 1902, p. 381 (Clarion Island, Revillagigedo Islands, Mexico).

Chars. subsp.—Resembling *Corvus corax sinuatus*, but wing, tail, and other parts smaller, particularly the bill.

Measurements.—Male:[1] wing, 365-421 (average, 398) mm.; tail, 202-231 (219.2); exposed culmen, 63-67 (65.2); height of bill at nostrils, 24-25 (24.4); tarsus, 64.5-73 (68.4); middle toe without claw, 42-46.5 (44.1).

Female:[2]   wing, 370-412 (average, 389.5); tail, 207-235 (218.8); exposed culmen, 57-68 (61.7); height of bill at nostrils, 21.5-24.5 (22.7); tarsus, 63-70 (66.6); middle toe without claw, 39-47.5 (42.2).

Type locality.—Clarion Island, Revillagigedo Islands, Colima, Mexico.

Geographic distribution.—Southwestern United States and extreme northwestern Mexico.   Breeds north to Umatilla, central northern Oregon; west to Narrows, central northern Oregon; Fort Klamath, central southern Oregon; Humboldt Bay, northwestern California; the Santa Barbara Islands, southwestern California; and Cerros Island, western Lower California; south to the Revillagigedo Islands, Colima, Mexico; east to Porto Bolandra, southeastern Lower California; the eastern coast of Lower California; Tucson and Apache, south-

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[1]Six specimens, from the Revillagigedo Islands, Lower California, and the Santa Barbara Islands, California.

[2]Sixteen specimens, from the Revillagigedo Islands, Lower California, and the Santa Barbara Islands, California.

eastern Arizona; San Rafael River, central Utah; Wells, north-
eastern Nevada; and Umatilla, central northern Oregon.

Remarks.—This race is so much smaller than *Corvus corax
principalis* or *Corvus corax europhilus*, particularly so far as the
bill is concerned, that no further comparison is necessary.   It
was originally described by Doctors Rothschild and Hartert[1]
from a specimen taken on Clarion Island in the Revillagigedo
group, and has been recently recorded by Mr. Ridgway[2] from
the Santa Barbara Islands, California.   It is undoubtedly
worthy of recognition as a subspecies, but it has, however,
much more of a geographic range than hitherto supposed.   Birds
from Lower California certainly belong to the same form; while
those from California, Nevada, all but the coast region of
Oregon, as well as most of Arizona and Utah, are so very little
larger, though somewhat verging toward *Corvus corax sinuatus*,
that they are certainly referable to *Corvus corax clarionensis.*
No specimens from the coast region of Oregon have been
examined, and they also may belong under the present race.

Measurements of specimens, including some of those from
the mainland of the western United States and Lower California,
are given in the table on pages 222 and 223.

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[1]Novit.   Zool., IX, No. 2, July 25, 1902, p. 381.
[2]Bull. U. S. Nat. Mus., No. 50, part III, 1904, p. 265.

THE OCCURENCE OF A PROBABLE GYNANDROMORPH IN THE HOMOPTERA.

Dwight M. DeLong.

Gynandomorphism occurs almost exclusively in insects and has been found in different and quite diverse orders, including Lepidoptera, Hymenoptera and Diptera, where it is commonly found, and more rarely in Coleoptera. This condition has never been reported, however, for a member of the Homoptera although previously noticed no doubt by workers in this group. Prof. J. G. Sanders has observed this condition in a single specimen of *Deltocephalus sayi.*

This curious phenomenon may be manifest in two different ways, either by an anterior-posterior arrangement of both male and female structures, or by a lateral arrangement. The latter type is by far the most prevalent and very often a butterfly or moth is found with one wing of male and the opposite one of female coloring; also flies, ants and bees will often display the lateral type, but it is very rare that anterior-posterior gynandomorphism is found.

The specimen at hand is *Chlorotettix unicolor* Fh. which was kindly sent to me with some other *Cicadellidæ* by Frank H. Lathrop and was collected at Corvallis, Oregon. The species is of a uniform green color and the structural characters of typical examples of the two sexes are just alike except the genitalia, so the occurrence of both male and female characters in this specimen is determined entirely by these genital structures, which are quite different and distinct in the two sexes.

By a study of this specimen and a comparison of the genitalia with those of the typical male and female, some very striking similarities and resemblances to parts of the genitalia of each sex is noticed and a combination of typical characters of both sexes is seen instead of a set of different or freakish characters. I will attempt to point out these similarities with the aid of the accompanying diagrams which show the genitalia of the typical male and female, also the specimen having the combination of characters.

If this is a gynandromorph which seems to be the case, it is of the anterior-posterior type, the anterior structures being female and the posterior male.

The last ventral segment of the abdomen is undoubtedly a female segment and contains the median notch on the posterior

margin which is characteristic of that sex. The segment in this case is much shorter than the typical female, but resembles it very much, while it bears no resemblance whatsoever to the last ventral segment or the valve of the male. The male valve in fact seems to be entirely missing and replaced by this female segment. The plates, however, are well developed and typical of the male of the species. Although slightly larger in size, the shape, structure and position are the same and the outer margins are similarly armed with spines.

Gynandromorph
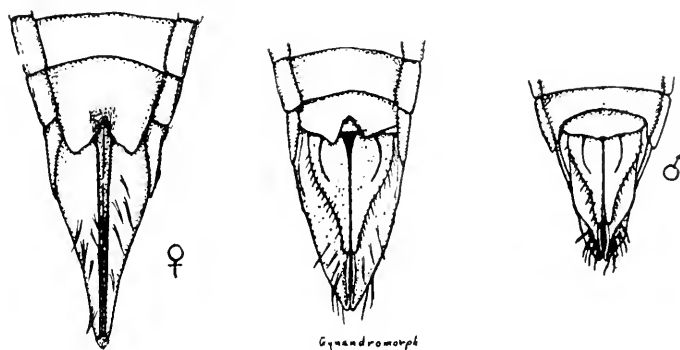
The pygofers resemble the male of unicolor more than the female structures. The opening with keeled sides at the posterior end resembles very closely the male, but the pygofers are not so strongly inflated at the middle. There is no trace, however, of an ovipositor which would be a conspicuous part of the genitalia in case it were a female and should extend from the base to the tip of the pygofers.

In the specimen in question a segment is found to lie just beneath the last ventral segment, and the edge of which protrudes slightly at the posterior end. This structure I am not able to homologize with a similar one in the typical genitalia of either sex; but it is the only one not accounted for, and which does not resemble in a very marked way some part of one of the other specimens.

From this comparison it is seen that there is an entire absence of male structures anteriorly, replaced apparently by typical female structures and a condition just the reverse of this for the posterior portion, so apparently is a good example of the anterior-posterior type of this phenomenon. This is not commonly seen and since it occurs in the Homoptera for which group it has never been reported, perhaps deserves mention here.

A NEW SPECIES OF CICADELLIDÆ FROM WISCONSIN.

Dwight M. DeLong.

Deltocephalus marginatus n. sp.

Closely resembling *D. bilineatus*, but with longer head and a black transverse band across margin of vertex between the eyes. Length 4 mm.

Vertex produced, twice as long at middle as next the eyes, width between the eyes equalling the length. Antennæ two and one-half times as long as vertex. Pronotum as long as vertex, produced and very strongly curved on anterior margin. Elytra quite long and slightly flaring; middle antiapical cell very long, constricted along central half.

Color: Creamy white with testaceous and dark markings. Face uniform creamy white, unmarked. Vertex with black, longitudinal, median, impressed line on middle half; two pale testaceous bands arise about one-third the distance from apex and extend across pronotum to middle of apex, where they end in two black spots on the disc. Each of these is bordered interiorly on the vertex by a fine black line, broken into spots, which converge at the apex; also partially bordered exteriorly by a small black dash. A black transverse band extends across the margin of vertex and recurves onto vertex

D marginatus

at either end along the eyes. Pronotum with four longitudinal testaceous bands. Veins of elytra white; the clavus and claval veins along suture broadly margined with testaceous. Outer margins of inner and two outer apical cells and adjoining costal cell, fuscous. Venter pale yellow, female segment with a large round black spot either side of notch.
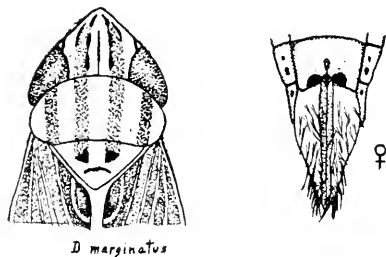
Genitalia: Female last ventral segment longer than preceding, with posterior margin broadly notched, sides of notch somewhat convexly rounded.

Described from two specimens from Amery, Wisconsin, collected August 13, 1916. In the Wisconsin list these were considered as *D. bilineatus* but with additional study it seems that they are quite distinct in the points mentioned. It may prove to be only a variety of that species, but I believe deserves specific rank.

A PRELIMINARY LIST OF THE ANTS OF WISCONSIN.*

A. C. BURRILL,
Entomologist of The University of Idaho, Moscow, Idaho,

and

M. R. SMITH,
Of The Truck Crop Insect Investigations, U. S. Department of
Agriculture, Baton Rouge, La.

The ants listed in this paper represent collections made by Dr. W. M. Wheeler, of Harvard University, Mr. C. E. Brown, of the University of Wisconsin, the writers and others. To Mr. T. E. B. Pope, Curator of The Milwaukee City Museum, the authors are indebted for a list of the species of ants in the museum, and to the other gentlemen mentioned, the authors are indebted for the use of their records.

The collector's initials, instead of his full name, are used for brevity.

Subfamily **Camponotinæ.**

Camponotus herculaneus L. subsp. *pennsylvanicus* De Geer.
  A. C. B.; Lake Puckaway, Wis., September 1, 1908.
Camponotus herculaneus L. subsp. *ligniperda* Latr. var. *noveboracensis* Fitch.
  A. C. B.; Lake Puckaway, Wisconsin, September 1, 1908.
Camponotus castaneus Latr. subsp. *americanus* Mayr.
  A. C. B.; Coons Valley, Wisconsin, September 21, 1911.
Camponotus herculaneus L. var. *whymperi* Forel.
  W. M. W.; White Fish Bay, near Milwaukee, Wisconsin.
Camponotus fallax Nyl. var. *nearcticus* Emery.
  W. M. W.; Wisconsin.
Lasius niger L. var. *americanus* Emery.
  A. C. B.; Milwaukee, Wisconsin, August 20, 1908.
Lasius niger L. var. *neoniger* Emery.
  A. C. B.; Janesville, Wisconsin, July 26, 1911.
Lasius umbratus Nyl. subsp. *mixtus* Nyl. var. *aphidicola* Walsh.
  C. E. B.; Milwaukee, Wisconsin, August 24, 1901.
Lasius claviger Roger.
  C. E. B.; Madison, Wisconsin, July 12, 1902.

Lasius interjectus Mayr.

C. E. B.; Milwaukee, Wisconsin, August 12, 1901.

Lasius latipes Walsh.

A. C. B.; Lake Puckaway, Wisconsin, September 1, 1908.

Prenolepis imparis Say.

M. R. S.; Madison, Wisconsin, October, 1917.

Brachymyrmex heeri Forel subsp. *depilis* Emery.

A. C. B.; Vernon County, Wisconsin, September 22, 1912.

Formica fusca L. var. *subsericea* Say.

A. C. B.; Ozuakee, Wisconsin, September 13, 1913.

Formica cinerea Mayr. var. *neocinerea* Wheeler.

M. R. S.; Madison, Wisconsin, October, 1917.

Formica neogagates neogagates Emery.

C. E. B.; Milwaukee County, Wisconsin, May 13, 1901.

Formica pallide-fulva Latr. subsp. *schaufussi* Mayr.

C. E. B.; Milwaukee, Wisconsin.

Formica pallide-fulva Latr. subsp. *schaufussi* Mayr. var. *incerta*
Emery.

C. E. B.; Milwaukee, Wisconsin, September 19, 1901.

Formica pallide-fulva Latr. subsp. *nitidiventris* Emery.

A. C. B.; Corliss, Wisconsin, July 19, 1911.

Formica pallide-fulva Latr. subsp. *nitidiventris* Emery. var.
fuscata Emery.

A. C. B.; Corliss, Wisconsin, July 19, 1911.

Formica pregandei Emery.

C. E. B.; Beaver Lake, Wisconsin, June 20, 1901.

Formica rufa L. subsp. *obscuripes* Forel.

C. E. B.; Milwaukee County, Wisconsin, July, 1902.

Formica rufa L. subsp. *aggerans* Wheeler.

M. R. S.; Madison, Wisconsin, October, 1917.

Formica rufa L. subsp. *aggerans* Wheeler, var. *melanotica* Emery.

M. R. S.; Madison, Wisconsin, October, 1917.

Formica truncicola Nyl. var. *integroides* Emery.

C. E. B.; Milwaukee, Wisconsin, June 21, 1901.

Formica sanguinea Latr. subsp. *rubicunda* Emery.

A. C. B.; Mayville, Wisconsin, July 25, 1909.

Formica sanguinea Latr. subsp. *integra* Emery.

A. C. B.; Milwaukee, Wisconsin, August 10, 1908.

Formica sanguinea Latr. subsp. *subnuda* Emery.

A. C. B.; Vernon County, Wisconsin, September 21, 1912.

Formica ulkei Emery.
  A. C. B.; Cedarsburg, Wisconsin, July 22, 1910.
Formica dakotensis Emery var. *specularis* Emery.
  H. Muckerman; Prairie du Chien, Wisconsin.

Subfamily **Myrmicinæ.**

Monomorium minimum Buckley.
  A. C. B.; Juneau County, Wisconsin, July 24, 1908.
Monomorium pharaonis L.
  A. C. B.; East Milwaukee, Wisconsin, September 7, 1908.
Aphaenogaster tennesseensis Mayr.
  A. C. B.; Lake Puckaway, Wisconsin, August 31, 1908.
Aphaenogaster fulva Roger. subsp. *aquia* Buckley.
  A. C. B.; Marquette, Wisconsin, September 1, 1909.
Aphaenogaster fulva Roger. subsp. *aquia* Buckley. var. *picea*
    Emery.
  A. C. B.; Marquette,.Wisconsin, September, 1909.
Stenamma brevicorne Mayr.
  C. E. B.; Milwaukee County, Wisconsin, May 11, 1911.
Myrmica rubra L., subsp. *brevinodis* Emery.
  C. E. B.; Milwaukee County, Wisconsin, June 16, 1900.
Myrmica scabrinodis Nyl.
  C. E. B.; Milwaukee, Wisconsin, June 21, 1901.
Myrmica scabrinodis Nyl. var. *sabuleti* Meinert.
  C. E. B.; Milwaukee County, Wisconsin, June 24, 1901.
Myrmica scabrinodis Nyl. subsp. *schenkii* Emery.
  C. E. B.; Milwaukee County, Wisconsin, August 30, 1901.
Myrmica scabrinodis Nyl. subsp. *schenkii* Emery var. *emeryana*
    Forel.
  A. C. B.; Juneau County, Wisconsin, July 24, 1908.
Leptothorax acervorum Mayr. subsp. *canadensis* Provancher.
  C. E. B.; Milwaukee County, Wisconsin, June 20, 1901.
Tetramorium guineense Fabr.
  C. E. B.; Milwaukee, Wisconsin, August 21, 1908.
Solenopsis molesta Say.
  A. C. B.; Fort Atkinson, Wisconsin, August 1, 1912.
Cremastogaster lineolata Say.
  A. C. B.; Madison, Wisconsin, May 18, 1912.

Subfamily **Dolichoderinæ.**

Dolichoderus (Hypoclinea Mayr.) *taschenbergi* Mayr. var.
A. C. B.; Juneau County, Wisconsin, July 24, 1908.
Tapinoma sessile Say.
A. C. B.; Madison, Wisconsin, May 18, 1912.

Subfamily **Ponerinæ.**

Ponera coarctata Latr. subsp. *pennsylvanicus* Buckley.
A. C. B.; Baraboo, Wisconsin, August 2, 1911.
Stigmatomma pallipes Haldeman.
A. C. B.; Osceola, Wisconsin, August 27, 1912.

OHIO ACADEMY OF SCIENCE.

Annual Meeting.

At a meeting of the Executive Committee, held in Columbus, on December 8th, it was decided to hold the next Annual Meeting of the Academy in Columbus, May 30 and 31, 1918. The usual detailed notice will be issued later.

Saturday, June 1, will be available for field trips for such of the sections as may desire to hold them, the late date being unusually adapted to this purpose.

A more prominent place on the program will be given to the exhibition of specimens, microscopic preparations, drawings, models, scientific apparatus, etc., than at previous meetings. It is expected that definite hours will be assigned for such demonstrations, when the exhibitors will be present to give any desired explanations.

EDWARD L. RICE, *Secretary.*

THE

OHIO JOURNAL OF SCIENCE

TABLE OF CONTENTS

ADDITIONAL RECORDS OF TENNESSEE CICADELLIDÆ.
(Hemiptera-Homoptera.)

DWIGHT M. DeLONG.

Two years ago the first attempt was made at listing the Cicadellidæ (Jassoidea) found in Tennessee. At that time I published a paper* containing records for some 212 species and varieties collected in various parts of the state, most of which were the records of the previous summer.

In view of the fact that the proof was not seen by the author after the manuscript was sent to press, a large number of errors, mostly typographical, occurred in this bulletin, which I will not attempt to correct here. In working over the material, however, I find that a few species have been incorrectly cited and I wish to change them at this time.

The species referred to as *Spangbergiella vulnerata* Uhl. should be *Spangbergiella mexicana* Bak. Also *Deltocephalus signatifrons* V. D. should be *D. sonorus* Ball.

The specimens described as *Typhlocyba nigridorsum* DeL. are no doubt extreme variations of *E. vulnerata* Fh. and with a good series of specimens, I would now place this form under *vulnerata* and very close to variety *nigra* Gill.

* Tenn. State Board of Entomology, Bull. 17, 1916.

In spite of the fact that Mr. Van Duzee has placed *Typhlocyba morgani* DeL. as a variety under *Empoa querci* Fh., I am still certain that it is a good species and has no resemblance to *querci*.   In fact it belongs in the Genus *Erythroneura* and I am sure Mr. Van Duzee has not seen specimens of this species. At the present time I have a good series and find them to be quite constant in their characters as described.

During the past two seasons additional material has been collected and the following pages include records for these as well as specimens unidentified at the time of publication of the previous paper. These are new records for the state, five of which are treated as new species and one as a new variety. The total now brings the list for Tennessee to 241 species and varieties.

Mr. Crumb has very kindly given to me his records of species not listed previously and I have mentioned his name as collector in each case.   Specimens not otherwise designated were collected by the author.

Macropsis occidentalis (V. D.).

Two specimens referred to this species were taken at Clarksville, Tenn., July 5 and 17, 1915.

Macropsis tristis (V. D.).

Four specimens collected July 8 were swept from wild plum by Mr. Crumb at Clarksville, Tenn.

Dræculacephala angulifera (Walk.).

Collected at Hixon during July, August and September, 1915, Mr. Crumb.

Gypona sp.

The species referred to is a new one in manuscript at present and described by Gibson.   I will not give the name here as I do not wish to make this a manuscript species.   One specimen was collected at Clarksville, July 15.

Gypona scarlatina Fh.

Six specimens from Clarksville, collected June 21 to July 15, five of them by Mr. Crumb.

Gypona spadix n. sp.

In general appearance resembling *scarlatina*, but shorter and more robust with reddish-brown color and distinct genitalia. Length, ♀ 9 mm. ♂ 8 mm.

Vertex decidedly produced, twice as long on middle as next the eye, width between the eyes slightly more than twice the length. Ocelli almost equidistant between eyes and middle line of vertex, and closer to anterior than to posterior margin. Pronotum twice as long as vertex and twice as wide as long. Elytra rather short and broad.
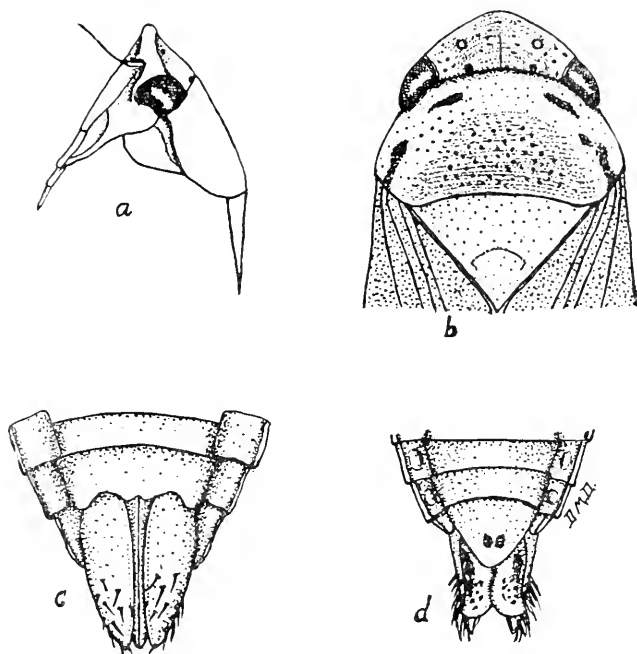

Fig. 1. *Gypona spadix* n. sp.
a, lateral view of head; b, dorsal view of head and pronotum; c, female genitalia; d, male genitalia.

Color: Face, eyes, loræ and genæ black or dark fuscous, sometimes narrowly margined with pale fuscous. Vertex, pronotum and scutellum brownish yellow, lightly flecked with bright red. Ocelli red, a pair of round spots behind these on the posterior margin of the vertex, brown. Posterior portion of pronotum and some irregular blotches on anterior half, darker. Elytra dull and rather dark chestnut brown; veins darker, dark bordered. In the female the outer veins are reddish in color. Cross veins between first and second sectors, those between apical and antiapical cells and the ends of claval veins along sutural line, black. Veins of apical cells rather heavily bordered with fuscous. Beneath yellow, bordered with fuscous, legs dirty yellow to fuscous.

Genitalia: Female last ventral segment almost one-half longer than penultimate. Posterior margin with narrowly rounded and prominent lateral lobes; broadly emarginate from these to a rather broad central lobe which is distinctly sinuate at the middle. Ovipositor dark in color. Male valve more than twice as long as preceding segment, gradually narrowed either side from base to roundingly produced apex. Plates longer than valve, half as broad as long. Outer margin undulated, inner margins overlapping toward apex and convexly curved to outer apical margins.

Described from one female and two males from Clarksville, Tenn., collected August 7th, and a single female from Ulster County, N. Y. Kindly loaned by Dr. Herbert Osborn. Type, male specimen in author's collection.

This is different from any of the species described, so far as I can determine from descriptions and authentically identified specimens of most of the nearctic forms.

Aligia modesta (O. & B.).

Four specimens were taken during July, 1917, at Clarksville.

Scaphoideus carinatus Osb.

Three specimens from Clarksville, July 26, 28 and 29.

Scaphoideus cinerosus Osb.

Two specimens, Clarksville, July 13 and 16.

Scaphoideus opalinus Osb.

Five specimens swept from grasses in pasture land at Clarksville, July 13 and 23.

Deltocephalus alboneura n. sp.

Resembling *D. vinnulus* Crumb in size and general appearance but with more conically produced head, distinctive coloring and genitalia. Length, 2 mm.

Vertex conically produced, twice as long at middle as next the eye, and slightly longer than width between the eyes. Pronotum longer than vertex, twice as wide as long, rather strongly produced on anterior margin. Elytra scarcely longer than abdomen, with reticulations on the clavus and middle antiapical cell divided.

Color: Face fuscous, marked with pale arcs and fading to dirty yellow above. Vertex dirty yellow with dark median impressed line on posterior two-thirds, a pair of spots at the apex, two either side along margin between these and the eyes, the inner one lying close to the eye, dark fuscous. A transverse fuscous band interrupted at the middle crosses the disc of vertex between anterior margin of eyes and terminates in a spot next either eye. Two oblique dashes either side of

median impressed line extend from this band to posterior margin, being close to and parallel with inner margins of eyes. Pronotum dark fuscous, outer margins, anterior median spot and five longitudinal vittæ, pale. Scutellum dark, a pale spot either side on outer margin half way to apex. Elytra dark fuscous, almost black, nervures pale, reflexed costal veins and inner apical cell broadly pale. Beneath black, keel of ovipositor and spots on pygofers pale. Legs dark set with white spines which are black at base.

Genitalia: Female last ventral segment concealed except a roundingly produced lobe at either side of preceding segment and extending beyond its apex; penultimate segment scarcely produced beyond preceding segment at the lateral margins but strongly convexly rounded at middle to three times its length. The apex slightly notched either side of middle so as to produce three distinct lobes.
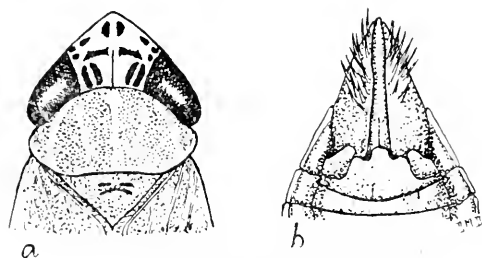

FIG. 2.   *Deltocephalus alboneura* n. sp.
a, dorsal view of head and pronotum; b, female genitalia.

Described from a single female specimen collected July 6, 1917, while sweeping short grasses on a rather steep hillside in an open woodland at the State Experiment Farm, Clarksville, Tenn. This specimen does not agree with any of the other described species and apparently is distinct. Type in author's collection.

Deltocephalus vanduzei G. & B.

One specimen from Clarksville, July 13, 1917.

Deltocephalus sonorus Ball.

Several specimens were taken during July and August at Clarksville and Tullahoma.

Euscelis striolus (Fall.).

Very abundant on grasses during July and August at Clarksville.

Phlepsius carolinus Lthr.

This species was recently described from a single female collected in South Carolina.   During the past season I have been able to collect great numbers of both sexes in Tennessee and am describing the male genitalia here.

Male valve almost as long as last ventral segment, gradually and evenly sloping from lateral margins to obtusely angled apex.   Plates almost as broad as valve at base and three times its length, very slightly concavely narrowed to rather broad, blunt and well rounded apices; outer margins set with about six large dark spines and very densely clothed with fine white hairs at basal lateral margins.

Phlepsius altus O. & B.

Abundant on short vegetation in open fields during August.

Phlepsius slossoni Ball.

Two specimens were collected by Mr. Crumb, October 8 and November 2 at Clarksville.

Dorydiella floridana Bak.

Two specimens from Clarksville, August 2, 1915, and September 3, 1914, were swept from tall grasses by Mr. Crumb.

Thamnotettix morsei Osb.

One specimen from Clarksville, October 11, 1916, by Mr. Crumb, and one collected at Elkmont, Tenn., September 27, by Mr. W. B. Cartright.

Thamnotettix proprius n. sp.

Resembling *shermani* and the other members of this group in general appearance, but with head narrower and more strongly produced, wing venation, coloration and genitalia distinct.   Length, 4.5 mm.

Vertex angularly produced, as long as width between the eyes, twice as long at middle as next the eyes, slightly shorter than pronotum which is almost twice as wide as long.   Elytra with the antiapical cells, especially the middle one and the cell just anterior to it, short.   Two cross veins are found between the first and second sectors.   Antennæ four and one-half times as long as vertex.

Color: Creamy white to light fuscous.   Face with a heavy band just below margin of vertex, a pair of arcs beneath this, a spot next either eye, and one below each antenna, black.   Vertex with a black band composed of three narrowly connected triangular spots either side of apex, interrupted on the middle line.   A large ochraceous blotch either side of middle arises behind this and extends to pronotum which is crossed with five longitudinal white vittæ.   Basal angles of scutellum

dark. Veins of elytra light, broadly margined with fuscous. Outer apical cell, a spot at apex of costal cell, one behind first cross vein, margin of clavus along suture, a spot at middle of outer clavus and antiapical cells broadly margined with dark fuscous. Venter dirty yellow, segments black at sides; male valve with a spot at apex and one either side at base, also a spot at base and outer margins of apical halves of plates, dark.
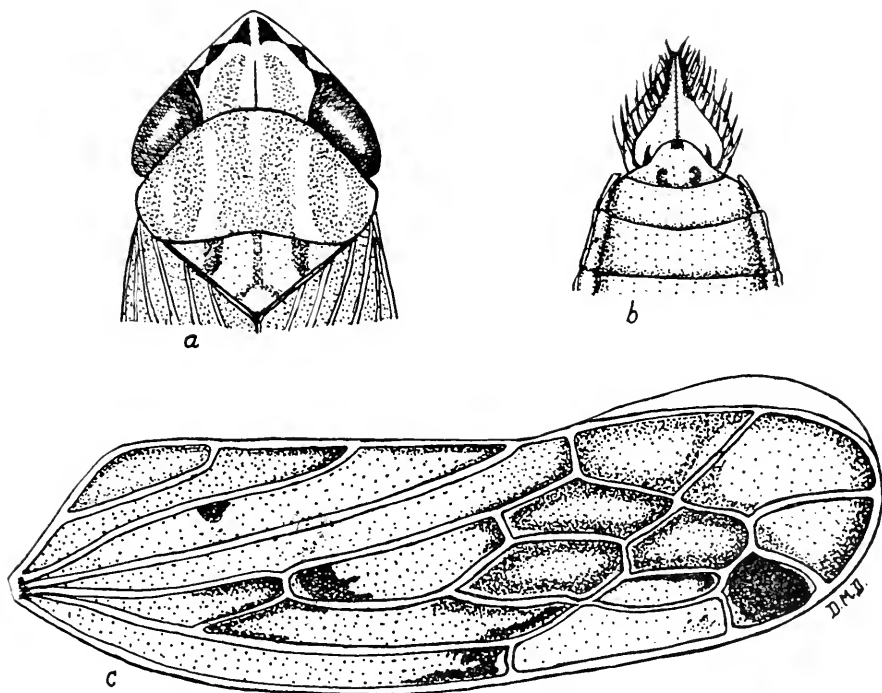

FIG. 3. *Thamnotettix proprius* n. sp.
a, dorsal view of head and pronotum; b, male genitalia; c, elytron.

Genitalia: Male valve almost as long as preceding segment, emarginate either side of roundingly produced apex; plates narrow, more than twice as long as valve, gradually narrowed to long, acutely pointed tips and very thickly set with yellow and black hairs. Pygofers broad, seen at either side of plates.

Described from two male specimens swept from canebrake August 8 and September 1, 1917. They agree in the characters mentioned above and are distinct from the other species of the genus. Type in private collection of author.

Chlorotettix sp.

The species referred to here has been in manuscript for almost a year and has been submitted for publication. I will not give the name here as I do not wish to make it a manuscript species.

Alebra albostriella var **fulveola** (H. S.).

Several specimens were collected during June and July at Covington, Colliersville and Clarksville, Tenn.

Alebra albostriella var. **rubrafrons** n. var.

Resembling *var. fulveola* in form and size but with darker color and face and vertex bright red. Length, 4 mm.

In structural characters this form is closely related to *albostriella*. The head is not produced and broadly rounded. The comparative width between the eyes is slightly less and the posterior margin of the vertex is more emarginate, almost angularly excavated in some specimens. The wing venation is also different.

Color: Deep orange yellow, darker than in *fulveola*. Clypeus, frons, face and vertex densely and almost uniformly bright, cardinal red; ocelli and rudiments of the arcs on the front pale. Scutellum with basal angles light, the remainder often flecked with red and the apical margin always red. Elytra with apical portion smoky sub-hyaline.

Male pygofers more inflated than in *fulveola*.

These characters are constant and distinct in the five male specimens at hand, which were collected at Clarksville, July 11, 1917, while sweeping small shrubs in an open woodland at the Experiment Farm. The ranking of this form will depend entirely upon the possibility for variation in the wing venation and how much emphasis should be placed upon this character, for the venation here is different from *albostriella* and its other varieties.

Alebra bicincta n. sp.

Resembling *albostriella* in form and size but with two brown cross bands extending across elytra. Length, 4 mm.

Head broadly rounded, not produced, almost parallel margined with anterior margin of pronotum. Venation of wings slightly different from *albostriella*.

Color: Milky white tinged with yellow. Face, disc of pronotum, basal angles of scutellum, and sutural margins of the wing washed with yellow. Two rather broad transverse bands extending across elytra, dark brown or fuscous. The anterior of these is just behind the apex of scutellum and extends obliquely to the costal margin; the posterior one covers the entire apical portion to a little anterior of the cross veins. Beneath pale yellow, ovipositor dark fuscous.

Genitalia: Last ventral segment of female rather strongly and broadly roundingly produced. Pygofers large, inflated.

Described from two female specimens taken at Clarksville, Tenn., August 13 and 31. The latter specimen was taken from sassafras while collecting at night with a flash-light. Type in private collection of author.
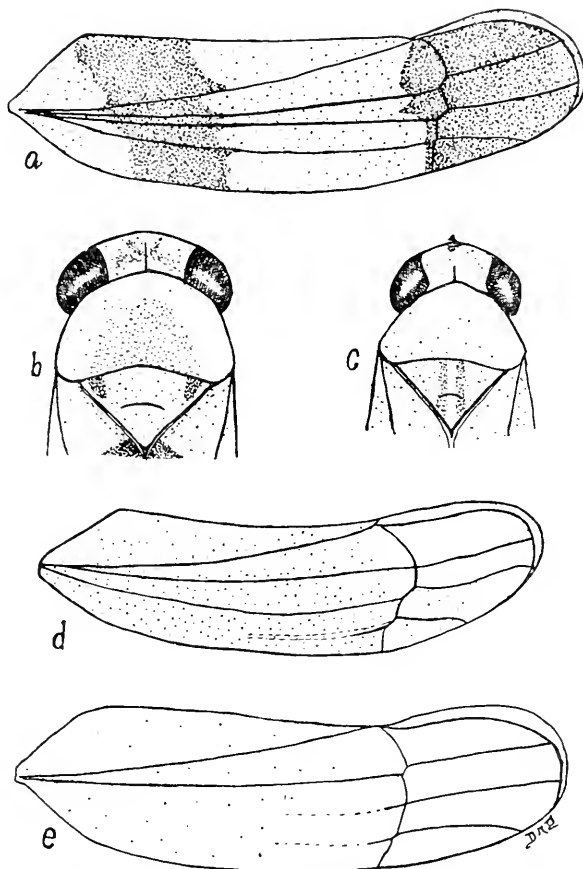

FIG. 4—a, b, *Alebra bicincta* n. sp.   a, elytron; b, dorsal view of head and pronotum.
c, d, *Alebra eburnea* n. sp.   c, dorsal view of head and pronotum; d, elytron.
e, elytron of *Alebra albostriella* var. rubrafrons n. var.

Alebra eburnea n. sp.

Resembling *albostriella* somewhat in general appearance but smaller with very narrow head and distinct wing venation. Length, 3.2 mm.

Vertex slightly produced, rather broadly rounded. Width between the eyes one-half greater than length. Pronotum twice as wide as long and decidedly wider than head. Elytra distinctly longer than abdomen.

Color: Ivory white; face, vertex, pronotum and scutellum, creamy white, the latter with two somewhat darker lines extending across middle from pronotum to apex. Elytra milky white, opaque from base to beyond cross veins, tips smoky. Beneath creamy white, last ventral segment of female with a dark line one-half the way to base from middle of apical portion. Ovipositor yellow.

Genitalia: Female last ventral segment strongly rounded and slightly emarginate at middle.

Described from a single female from Covington, Tenn., swept from wild-grape June 18, 1915. By a comparison with the species of the genus this seems so distinct in size and form that I describe it here. Type in author's collection.

Alebra fumida Gill.

A single specimen collected July 6 at Clarksville has been referred to this species. The specimen at hand is shorter and more robust than typical individuals of *fumida* which are from its type locality. It also has a different wing venation, but because of its marked resemblance in general appearance, I hesitate to describe it as a different form until more material is available for study.

Dikraneura cruentata Gill.

Four specimens were collected during July. All of these lack color markings except the black lines on the cross veins. The specimens are decidedly smaller and have a different character of the wing from that pictured by Gillette, but no doubt belong here.

Erythroneura hartii Gill.

Abundant on apple during July and August.

Erythroneura rubroscuta Gill.

One specimen from Clarksville, June 30, 1915.

Erythroneura comes var. maculata Gill.

Abundant on sycamore during August and September.

THE PARASITES OF LEAF-HOPPERS.
## With Special Reference to Anteoninæ.

F. A. FENTON.

PART II.

TABLE OF CONTENTS.

PHYLOGENY.

The relationship of the *Anteoninæ* to the *Homoptera* is shown in the accompanying phylogenetic tree. It is seen that they are parasitic on the *Membracidæ, Fulgoridæ,* and *Cicadellidæ*—three rather closely-related families. Up to the present time there are no records of any dryinid being parasitic on a Cercopid. If this holds true, it may be said that the spittle-forming habit
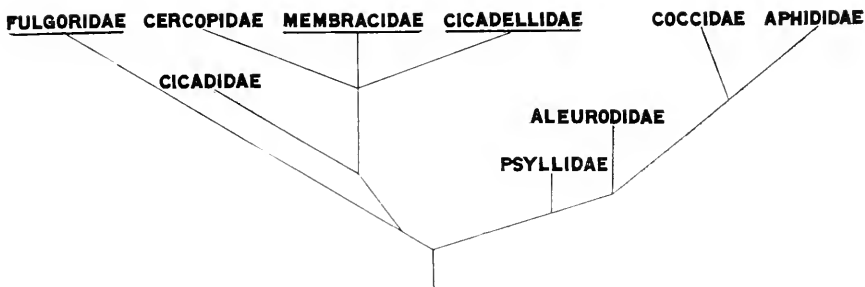
of this group may protect the nymphal stages of these insects, and that the adults are usually too large and active for the more highly specialized *Anteoninæ*. There is but one record of dryinid parasitism among the *Membracidæ*—that of a poly-embryonic form *Aphelopus theliæ* Gahan mss. parasitic on *Thelia bimaculata** (Kornhauser, 1915–1916).

In the *Cicadellidæ,* as noted, three of the six sub-families are at present known to be subject to parasitism by *Anteoninæ,* as indicated in the above phylogenetic tree of the family. Fifteen genera in the *Jassinæ* are attacked, which are chiefly grass-

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* According to Professor Kornhauser, the adult parasite was separately identified by both Mr. Brues and Mr. Gahan as belonging to the *Anteoninæ.*

TYPHPLOCYBINAE

JASSINAE

GYPONINAE

BYTHOSCOPINAE

CICADELLINAE

PAROPINAE
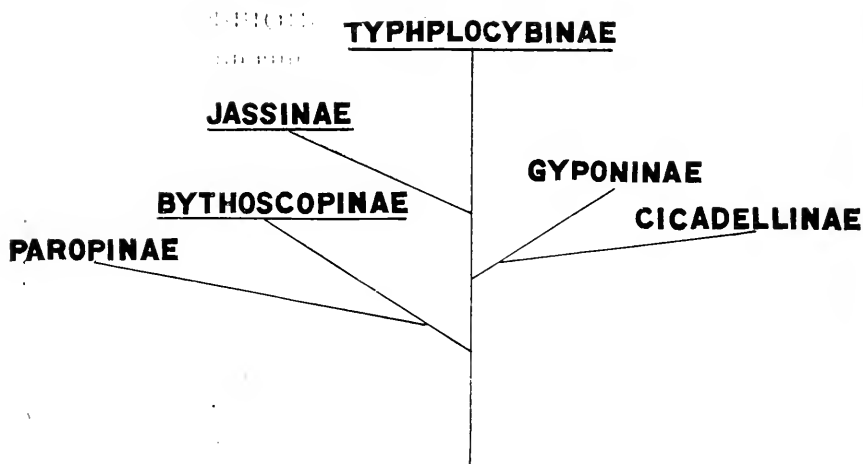
inhabiting forms, and but eight genera in the *Bythoscopinæ*, *Cicadellinæ* and *Typhlocybinæ*. It is interesting to note that the only genus parasitizing the *Typhlocybinæ* is *Aphelopus*, which is the most primitive and generalized genus in this sub-family. This same genus is the one found parasitizing Membracid nymphs. *Anteoninæ* parasitizing genera in the other sub-families noted are all higher and more specializd types.

DELPHACINAE

FLATINAE

ISSINAE

ACANALONIINAE

TROPIDUCHINAE

CIXIINAE

ACHILINAE

DICTYOPHORINAE
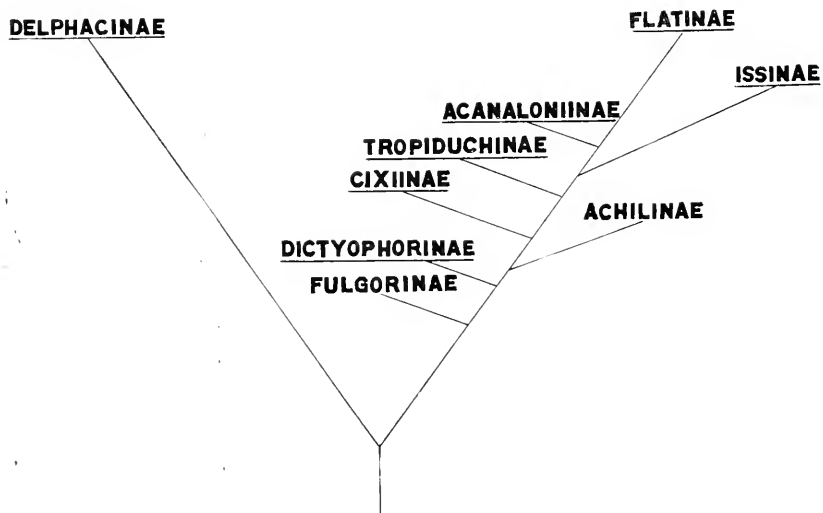
FULGORINAE

By far the greatest number of host records today in the family *Fulgoridæ* are in the sub-families *Delphacinæ* and *Flatinæ*, the highest specialized groups of this family. Ten genera in each of these are paratitized, while but one or two genera are parasitized in the *Issinæ, Acanaloniinæ, Tropiduchinæ, Cixiinæ,* and *Dictyophorinæ*. No species in the others are at present known to be dryinized. Only the highest specialized genera in the *Anteoninæ* parasitize this group, thus suggesting that as a group they were first parasitic on the *Cicadellidæ*, later becoming adapted for parasitizing the *Fulgoridæ*. Most of the species are subject to parasitism in their immature stages, the adults apparently being free, except in the less active, smaller, and short-winged forms as *Liburnia*.

Apterous species with both arms of chela lamellate, hosts Fulgoridæ, sexual dimorphism marked. *Pseudogonatopus* type.

Apterous species with one arm of chela lamellate, hosts Cicadellidæ, sexual dimorphism marked. *Gonatopus* type.

Winged species with both arms of chela lamellate, hosts Fulgoridæ, sexual dimorphism marked. *Echthrodelphax* type.

Winged or partly apterous species, lateral arm of chela serrate, median arm bare, hosts Fulgoridæ, sexual dimorphism. *Phorbas* type.

Winged species with one arm of chela lamellate, hosts Cicadellidæ, sexual dimorphism. *Chelothelius* type.

Winged species, chela fairly specialized and freely extensile, hosts Cicadellidæ, sexual dimorphism. *Deinodryinus* type.

Winged species, chela in some species only partly extensile, hosts Cicadellidæ, sexual dimorphism but not extreme. *Chelogynus* type.

Winged species, chela in some species not extensile, hosts Cicadellidæ. *Anteon* type.

Winged species, no chela, hosts Cicadellidæ and Membracidæ, no sexual dimorphism. *Aphelopus* type.

Primitive Dryinid
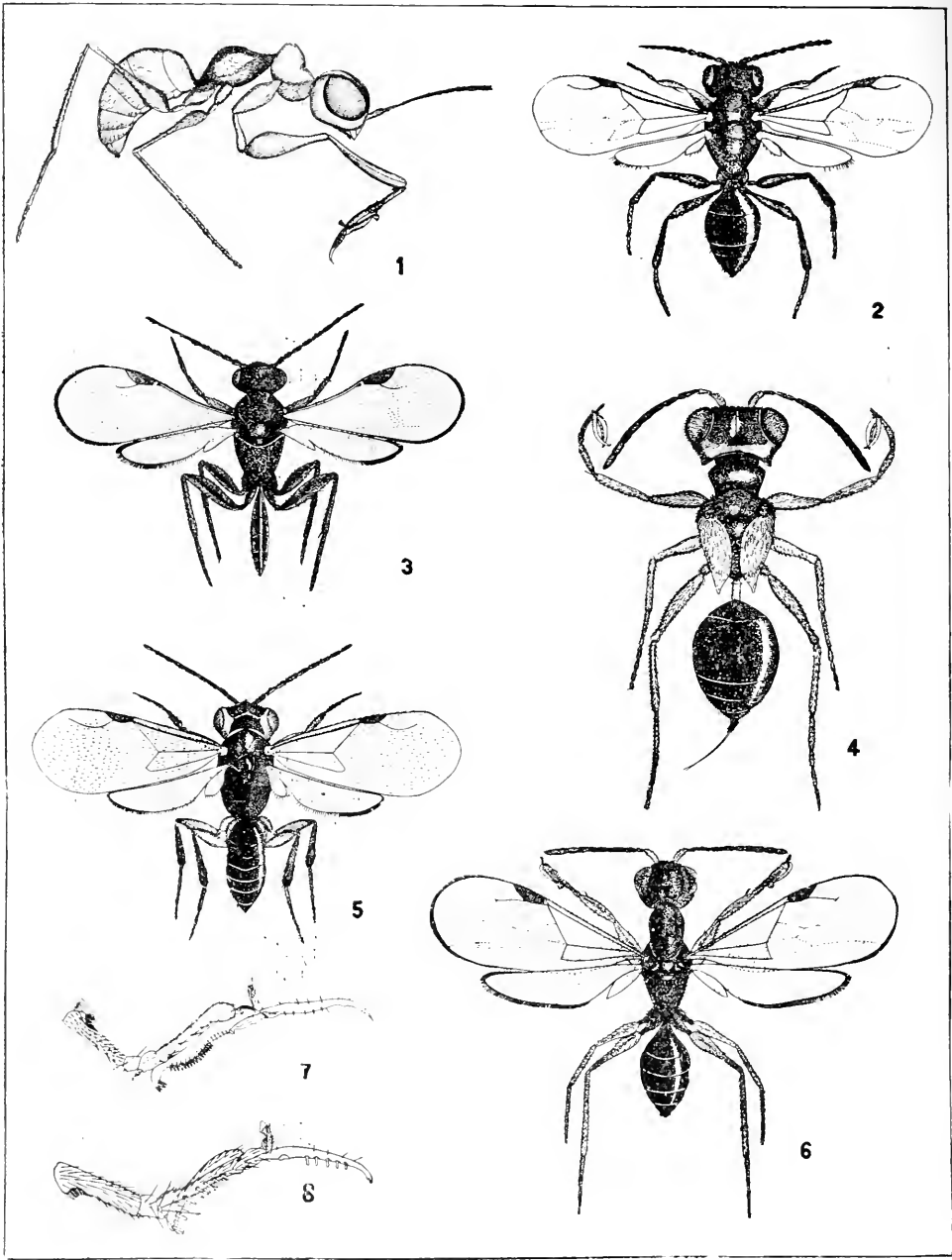
TAXONOMY.

The relationships of the *Anteoninæ* in the *Hymenoptera* is a much-debated question, but it is now generally concluded that they are a sub-family of the *Bethylidæ* in the super-family *Proctotrupoidea*. The larval sac is a structure which at once distinguishes all *Anteoninæ*, and at the same time shows their possible affinity with such other forms that present this peculiar characteristic. Of the three other sub-families that Kieffer (1914) places with them under the *Bethylidæ*, little is known of the life history of the *Emboleminæ* and the *Sclerogibbinæ*. However, with the sub-family *Bethylinæ*, the genus *Harpagocryptus* Perkins shows its relationship in the similar larval sac found on the Orthopteron *Trigonidium*, which resembles that of the genus *Aphelopus*. Perkins (1912) says: "It is interesting to note that the elongate larval sac of *Harpagocryptus* and *Aphelopus*, so different from those of the other *Dryinidæ (Bethylidæ)*, is correlated with the possession of simple front tarsi in the females." In working out the life cycle of *Rhopalosoma poeyi* Cresson, parasitic on the jumping tree-cricket, *Orocharis saltator* Uhl., Hood (1913) brought out the interesting fact that here there is also a larval sac very similar to that of the *Anteoninæ*. In commenting on Mr. Hood's paper in the same meeting, Mr. Rohwer said: "One is confronted with the remarkable resemblance between the larva of *Rhopalosoma* and some of the dryinids. Perhaps the *Rhopalosomidæ* and the *(Dryinidæ) Anteoninæ* had a common origin, as the larvæ would indicate, and the adults have specialized along different lines, though retaining certain characters in common." Ashmead placed this genus in a new family, which he included in the super-family *Vespoidea;* and Rohwer believes that this is the more nearly correct view. However distinct the adults of *Rhopalosoma* may be from the *Anteoninæ*, the fact that larval sac is a feature in common with both, and the development of this structure on two widely separated insect groups—the *Homoptera* and *Orthoptera*—indicates at once an adaptation to the jumping habit of these insects.

The development and specialization of the chelate front tarsus in the female may be taken as a criterion showing the evolution of the group. The chelate tarsus is an adaptation of the parasite to the structure and habit of the host. Along with

the specialization of this structure, such other modifications as
the loss of wings and shortening of the antennæ in the female—
all leading to sexual dimorphism—can be correlated.   Thus,
as is shown in the above phylogenetic tree, we start with
Aphelopus as the most primitive and generalized group in which
there is no sexual dimorphism.   We note specialization pro-
ceeding along two different lines: one a loss of wings, probably
due to the general activity and abundance of the host; the
other a development of the chelate tarsus as an aid to catching
and holding the active prey.   With the latter again specializa-
tion has taken place with regard to the kind of host attacked.
Perkins (1905) has observed that *Anteoninæ* parasitizing jassids
have the lateral claw of the chela without lamellæ, and generally
curved, (Plate I, Fig. 7).   Those confining their attacks to the
Fulgoridæ having the lateral claw of the chela with lamellæ,
generally nearly straight and with a slight notch near the tip,
(Plate I, Fig. 8).   So characteristic is this structure of the chela
that the host family can be ascertained at once by examining
the female.

Specialization has taken place primarily and more markedly
in the female, the males of even those species having the most
highly specialized females being very similar to the males of
the most generalized genus.   This is due to the greater need for
activity on the part of the female in the hunting and capturing
of the active hosts.   In fact, males of some of the more highly
specialized genera are still unknown and these species are
possibly entirely parthenogenetic.

LIFE HISTORIES OF SPECIES.

Gonatopus erythrodes (Perkins).

July 3, 1917, a large number of *Deltocephalus inimicus*
nymphs bearing dryinid larval sacs were collected in a run-down
meadow near Castalia, Ohio.   About thirty per cent of the
nymphs of this species were parasitized.   They were placed
individually in shell vials for separate study.   This field was
revisited several times on successive days, but after July 15 the
parasites had disappeared, the remaining nymphs having
matured.   July 9 the first parasite killed its host, and July 17
the last one of the series of sixteen individuals collected had
entered the ground to pupate.

Adults issued between Agust 3 and 11, the time spent in the cocoon averaging about twenty-five days. One female issued August 6 and was allowed to oviposit August 17, without having been fertilized by a male. This female pounced upon the first nymph and oviposited in it, and within five minutes repeated the operation upon another. She oviposited in thirteen nymphs from August 17 to 21 inclusive. Each nymph after being parasitized, was placed in a separate vial. After two or three ovipositions, the parasite rested, paying no attention to other nymphs. The greatest number of eggs laid in a single day was six, although this number is probably too low for natural conditions. Nymphs in the third and fourth instars are parasitized, the fourth instar being the most susceptible.

The egg measures .2 mm. by .12 mm. and is oval, pale yellow in color, without any sculpturing on the chorion.

Two of the nymphs did not develop parasites, although they were paralyzed and the ovipositor inserted. Instead, they matured and were perfectly normal in every way, so far as could be observed. This indicates that the sting itself will not produce castration nor stop development, but that the larva itself must produce some condition that brings about these changes. Six nearly-developed eggs were found in the ovaries of this female, thus proving that the eggs are not developed all at one time but instead are gradually matured, and that the life of the adult and extent the oviposition period are relatively long. This female lived seventeen days and died only because of abnormal conditions. The total life of this individual is summed up below.

Date Issued	Date First Egg Laid	Date Last Egg Laid	Total Oviposition Period	Total Number of Eggs	Average per Day	Died	Total Life
Aug. 6	Aug. 17	Aug. 21	5 days	12	2+	Aug. 27	17 days

This female issued from a sac located on the abdomen of the host, and invariably oviposited in this same position on the nymphs. In this species the greatest number of sacs are found between the fourth and fifth abdominal segments. They are found as frequently attached to the right side of the body as to the left. The place of attachment is shown below.

ABDOMEN.

Segments............	1–2	2–3	3–4	4–5	5–6	6–7
Right...............	0	0	3	3	1	0
Left................	0	0	2	3	2	0

Five days after oviposition, a dark discoloration is noticed on the parasitized nymph near the region where the ovipositor is inserted. This is due to the presence of the developing parasite within the tissues, surrounded by its first exuvium, the dull gray color of which shows through the opaque yellow body-wall of the host. Thus it seems likely that the egg hatches very shortly after being laid, and that the first instar is relatively of short duration. Two days later, a week after oviposition, a tiny gray vesicle protrudes between the segments of the nymph. This is the second larval instar enclosed within the first exuvium. At this phase, the entire outlines of the parasite can be seen within the body of the jassid, the anterior end reaching as far anteriorly as the posterior margin of the preceding segment.

The second molt occurs in from seven to ten days after the appearance of the sac, and the third three to four days later. The larva enters the fifth instar and kills the host eighteen or nineteen days after the sac becomes external. Within a few hours the host is devoured, and the parasite leaves it. The nymphs are killed in from twenty-four to twenty-five days after oviposition.

The larval sac is about 1 mm. in width, oval, compressed and dull black in color, being composed of the typical three exuviæ, the first being smooth and shining, the second dull and roughened on the outer half, and the third being distinctly rugosely sculptured.

Immediately after emerging the white, grub-like larva seeks the soil, beneath which it spins a compact oval, white cocoon covered with soil particles. Some of the larvæ in the second generation spin their cocoons above the soil, attached to some convenient object, a fact not observed in those of the first or summer generation. The outer cocoon is completed in a day, but longer time is required for the completion of the inner. The larvæ of the last generation can be seen spinning within the cocoon for days after it is apparently completed. The length of

time spent in the cocoon in the summer is from twenty to thirty-one days, averaging twenty-five and a half days. In one case an adult was noticed within the cocoon ready to issue seventeen days after it was spun. This issued two days later. Of ten cocoons spun during the summer, seven contained larvæ that pupated soon, the rest remaining as larvæ over winter.

The life cycle is summarized in the following table:

	Maximum	Minimum	Number of Specimens
Time between oviposition and appearance of sac....................................	7 days	5 days	5
Time between appearance of sac and death of host......................................	19 days	18 days	4
Time spent in cocoon.....................	31 days	20 days	6
Total............................	57 days	43 days	

There are two generations a year, the adults for the first issuing during June, and those for the second in early August. Winter is passed in the larval stage in the cocoon. This species is parthenogenetic.

Gonatopus contortulus Patton.

This species parasitizes *Deltocephalus sayi* adults and has been reared from no other host. The oval, dark grey egg is always laid between the anterior abdominal segments, generally being thrust entirely beneath the cuticle but occasionally being attached externally in the suture between the segments. In the majority of cases it is laid between the second and third abdominal segments, either on the right or left side, but it may also be laid between the first and second or third and fourth. The female used in the experiments was unfertilized, having been bred from a parasitized hopper taken in the field. She issued August 17 and died August 30, thus living thirteen days. A total of 17 eggs was laid in a period of nine days as the table below indicates:

	Date—August									Total 9 days
	18	19	20	21	22	23	24	25	26	
No. of Eggs..	2	0*	2	3	0*	4	2	1	3	17 eggs

* No hoppers were given to the female August 19 and 22.

The normal longevity and number of eggs a female of this species can lay under natural conditions is probably greater than the above records indicate. However it can be seen that the adult life of the female extends throughout several weeks and that the oviposition period is prolonged. Females dissected show but few eggs matured in the ovaries and this fact, together with the presence of all stages of the parasite in the field at a given time, seem to prove this. The female generally made no attempts at oviposition after two or three hoppers had been parasitized. At least twenty minutes and generally over an hour elapsed before the second attempt.

An adult *Deltocephalus oculatus* was placed in the cage to determine whether the parasite was confined to *sayi* as its host. The hopper was seized and partly eaten without any attempt at oviposition.

The first larval stage is passed within the tissues of the host and when the egg is laid externally the young larva must penetrate into the host of its own accord. Shortly after the first molt the larva begins to push its way out between the segments through which the egg is laid. It molts for the first time and enters the second instar four days after oviposition. Nine days later larvæ are found to be in the third instar which is characterized by the two large head lobes. Within twenty-five days after the egg is laid the larva enters into the fifth stage. It issues from the sac and kills the host in from 26 to 31 days after the latter has been parasitized. The mature larva is 4 mm. in length, white, with no visible hairs.

The larval sac is oval, and shining black in color, the third exuvium being distinctly rugosely sculptured. The oval, white cocoon is spun above the ground on the grass blades and is 4½ mm. long and ½ mm. wide. The pupal period extends from 22 to 24 days, the adult remaining in the cocoon for two or three days before issuing, through an irregular hole near one end.

The species parthenogenetic, unfertilized females producing females. There are two generations a year, the winter being passed in the larval stage within the cocoon. The following table summarizes the life history experiments. The pupal stage was passed through in the green house and is included in the table because the length of time under artificial conditions is identical with that of normal summer conditions.

TABLE I.—Life Cycle of *Gonatopus contortulus*.

Experiment Number	Date Egg Laid	Time of Oviposition	Location of Egg	Date Host Killed	No. Days Host Lives	Date Pupated	Date Issued	Length Pupal Stage	Emerged From Cocoon	Total Life Cycle	Sex
49a	Aug. 18	2:00 P.M.									
49b	Aug. 18	4:50 P.M.	Left side abd., segs. 3-4								
49c	Aug. 20	3:35 P.M.									
49d	Aug. 20	4:50 P.M.									
49e	Aug. 21	10:55 A.M.	Left side abd., segs. 2-3.								
49f	Aug. 21	11:30 A.M.	Left side abd., segs. 1-2.								
49g	Aug. 21	4:15 P.M.									
49h	Aug. 23	4:45 P.M.	Right side abd. segs. 3-4.	Sept. 24	31 days	Feb. 9-11	Mar. 4	22 days	Mar. 6	53 days	Female
49i	Aug. 24	3:35 P.M.									
49j	Aug. 25	11:30 A.M.	Left side abd., segs. 2-3	Sept. 20	26 days	Feb. 6-8	Mar. 2	22 days	Mar. 4	48 days	Female
49k	Aug. 26	12:00 Noon	Left side abd., segs. 2-3.								
49l	Aug. 26	12:20 P.M.									
49m	Aug. 26	12:24 P.M.		Sept. 22	27 days	Feb. 4-6	Mar. 2	24 days	Mar. 4	50 days	Female

Haplogonatopus americanus Perkins.

Nearly mature nymphs and adults of *Liburnia campestris* and *L. Lutulenta* are found bearing the larval sacs of *Haplogonatopus americanus* throughout the latter part of July and early August in the vicinity of Sandusky, Ohio, and in June and August about Columbus, Ohio. *L. campestris* is by far the more heavily parasitized species of the two, possibly due to its greater abundance. The larval sac of this parasite is always dorsal in position and attached to the posterior region of the host's abdomen. The greater number of sacs are found protruding between the 5th and 6th segments, but there is some variation as the following table shows:

Segments	1–2	2–3	3–4	4–5	5–6	6–7	7–8
Dorsal median........	0	0	0	2	6	0	0
Dorsal right..........	0	0	1	2	7	0	0
Dorsal left...........	0	0	0	3	7	1	0

Unlike the other two species studied the females do not oviposite readily in captivity and so but few data were obtained in the oviposition experiments. At the time the adults issued nearly all the Liburnias had matured and there is a possibility of this species living until a second generation of nymphs is produced. This is not likely since this species parasitizes adults.

The process of oviposition was observed in a few instances and is similar to that already described for *Gonatopus erythrodes* (Perkins), except that the tip of the ovipositor is curled upward and thrust in the dorsal side of the abdomen. Parasitized hoppers taken in the field bearing sacs containing larvæ in the second instar are killed by the mature larva within eight to eleven days.

When the larval sac becomes visible on the outside of the body of the host, it is dull grey or brown in color but when fully developed it is brown or dark yellow. It is then 1 mm. in length and oval in shape. The first exuvium is smooth and shining and is always darker in color than the other two. These comprise the greater part of the sac and are dull and roughened. The spiracles are dark brown and distinctly visible along the median line of the different exuviæ.

After leaving the host the white elongate larva almost immediately starts spinning the cocoon on some convenient object above the ground. The cocoon is completed in two days and is

elongate oval and white in color being 3 mm. long and 1 1-3 mm. wide.   Soon after the cocoon is completed, generally within three days, the larva pupates. The pupa is typical, being 2½ mm. in length and .9 mm. wide.   In from nine to eleven days during the summer and in twenty-six days during the fall, the adult issues through a hole at or near one end of the cocoon. The entire time spent in the cocoon varies from fourteen to seventeen days during the summer and from twenty-four to thirty-five days during the fall.   Males are as numerous as females.

There are two generations a year in the latitude of northern Ohio and three in the vicinity of Columbus, larvæ of the third hibernating within the cocoons.

TABLE II.
Life Cycle of *Haplogonatopus americanus*.

Exp. No.	Date Cocoon Spun	Date Pupated	Date Issued	Length Pupal Stage	Time Spent in Cocoon	Sex of Parasite	Stage of Host	Sex of host	Host Species
22a	July 20		Aug. 6		17 days	♂	nymph	?	Liburnia nymph
23a	July 18		Aug. 2		15 days	♂	nymph	?	Liburnia nymph
23b	July 18	July 25	Aug. 3	10 days	16 days	♀	adult	♂	Liburnia campestris winged
23d	July 20	July 26	Aug. 3	9 days	14 days	♂	nymph	?	Liburnia nymph
24a	July 20		Aug. 5		16 days	♂	nymph	?	Liburnia nymph
24b	July 21		Aug. 6	16 days	16 days	♀	nymph	?	Liburnia nymph
24c	July 21		Aug. 6		16 days	♂	nymph	?	Liburnia nymph
24e	July 20		Aug. 5		16 days	♀	nymph	?	Liburnia nymph
25d	July 22	July 27	Aug. 6	11 days	15 days	♂	nymph	?	Liburnia nymph
25e	July 20		Aug. 5		16 days	♀	nymph	?	Liburnia nypmh
25f	July 22	July 27	Aug. 6	11 days	15 days	♀	nymph	?	Libutnia nymph
25g	July 20	July 26	Aug. 5	11 days	16 days	♀	nymph	?	Liburnia nymph
25h	July 22	July 27	Aug. 6	11 days	15 days	♂	nymph	?	Liburnia nymph
35b	July 27		Aug. 7		11 days	♀	adult	♂	Liburnia lutulenta winged
39a	Aug. 2		Aug. 26		24 days	♀	nymph	♀	Liburnia nymph
42	Aug. 5	Aug. 11	pupa preserved			♂	adult	?	Liburnia lutulenta
51a	Aug. 26	Sep. 4	Sep. 20	26 days	35 days		nymph	?	Liburnia numph

Chelogynus osborni n. sp.

This species parasitizes both nymphs and adults of *Chlorotettix unicolor* Fitch, infested individuals of which are found from late June to middle July in the vicinity of Sandusky, Ohio. The sac is always located on the thorax either to the right or left side between the meso- and metathorax in the suture just below the middle coxa. When it first appears it is very small and blue green in color, being almost invisible against the green of the host. After five days it assumes the normal black color and when fully developed it is nearly circular, laterally strongly compressed, and dull black in color. The third exuvium is strongly rugosely sculptured. Nine days after the appearance of the sac the parasite maggot issues and kills the hopper. It is relatively large, green, and bears few scattered hairs. The male parasite is usually much smaller and does not completely devour the host. The cocoon is spun in the soil and is 3.5–4.5 mm. in length, broadly oval, white, with sand or soil particles plastered over the outside. There is but one generation a year in this region, the larvæ hibernating and pupating the following spring.

Phorbas mirabilis (Perkins).

This species attacks both nymphs and adults of *Brucomorpha oculatus* Newm., the latter being more often parasitized. From one to three sacs may be attached to one individual and all may mature even though they are of different sizes. The sacs are always found protruding between various segments on the hopper's abdomen. In one specimen three sacs were found attached between the second and third, third and fourth, and fourth and fifth abdominal segments respectively. The fully developed sacs vary from one to two mm. in diameter. They are shining black in color, the outer exuvium being distinctly rugosely sculptured. The larva is of a pale purple color when it first matures. The cocoon is spun in the soil and is large varying from 2 to 4 mm. in length and 1 mm. in width. It is very tough and composed of white silk, intermixed with soil, so that it is of a dull brown color. The adult escapes through a large, ragged hole cut through at one end. There are two generations a year, the first occurring in July and the second in September.

Aphelopus dikraneuri n. sp.

Aphelopus dikraneuri n. sp. parastizes adults of *Dikraneura fieberi* (Low), which is found to be quite extensively infested with this parasite in the vicinity of Columbus in July and September. The sac is found attached to the anterior region of the abdomen either to the right of left side, the position of attachment varying somewhat as the following table shows:

ABDOMEN.

Segments	1–2	2–3	3–4	4–5	5–6	6–7
Right................	1	7	1	0	0	0
Left.................	1	8	3	0	0	0

The sac is opaque yellow in color, elongate oval, and 1 mm. in length. Because of its small size, the first exuvium is usually overlooked, but it is smooth and shining, while the other two are dull and finely punctate. The second exuvium is often brown in contrast to the other two. Under reflected light the empty sac is irridescent.

The mature larva is white, elongate, with numerous hairs. The cocoon is spun just below the surface of the soil. It is small, white and oval, generally being coated over with soil. There are two generations a year.

The above description and life history is true of all species of *Aphelopus* parasitizing *Dikraneura, Empoasca, or Erythroneura*. It is particularly similar to that of *Aphelopus comesi* n. sp. parasitizing *Erythroneura comes* Say. This species was found to be very abundant in one grape vineyard in Columbus during the latter part of October, 1917. As high as 80% of the grape leaf hoppers were parasitized. Adults of *A. comesi* issued in May the following year.

The following classification is based upon Kieffer's Monograph of the Bethylidæ (1914).

Subfamily ANTEONINÆ.

Dryinidæ (part.), Haliday, Ent. Mag., v. 4, p. 411, 1837.
Dryininæ, Haliday, Hym. Syn., p. 3, 1839.
Dryinoidæ, Förster, Hym. Stud., v. 2, p. 94, 1856.
Dryinini, C. G. Thomson, Ofv. Ak. Forh., v. 17, p. 175, 1860.
Anteonidæ, Kieffer, Bull. Soc. Metz, v. 27, p. 108, 1911.
Anteoninæ, Kieffer, Das Tierreich, 41 L, 1914.

Female: Body sometimes lengthened or very elongate, sometimes somewhat compact. The length varies between 1.5–10 mm. Head viewed dorsally transverse, almost square or rounded. Mouth on the anterior end of the head. Mandible three or four-dentate, in one species stated to be two-dentate. Antennæ ten-jointed originating close behind the clypeus, slender, filiform, or distally slightly and clavate. Eyes very large and prominent (*Lestodryinini* and *Gonatopodini*) or moderately large in the others. Ocelli three, mostly forming a triangle, in apterous forms often lacking. Wings and tegulæ often entirely lacking, seldom reduced. Fore wings with pterostigma, two or three closed basal cells (subcostal, median, and submedian), one distal and generally anteriorly open radial cell. Anal vein often distinct. Traces of a cubital as well as two discoidal cells, namely, one distal median cell and one distal submedian cell; in the *Aphelopini* and in two other species only costa and radius are developed. Hind wings lobed. Legs slender, femur in form of a reversed club, tibia only slightly thickened, spur of fore tibia with a transparent lamella, extending for its length, abruptly ending before the tip, the spur thus appearing bi-lobed, claws of the four hind legs and in the male in the fore legs generally with one broad proximal or divided tooth.

In all females, except in the tribe *Aphelopini* the fore legs are modified. The coxa is excessively elongated, often more than half as long as the femur, the trochanter is a long, often stalked proximally and somewhat curved joint, which is often five times as long as the corresponding joint on the other legs, femur proximally strongly club-shaped, tibia thicker and shorter than the others, the tarsus ending in an almost bare chela, which is generally thrown backward, lying close to the tarsus, ventrally or dorsally, and generally reaching to the proximal end of the third, seldom the fifth, the fourth or the second joints; the fore legs are therefore called "Raubfusze," "Pedes raptorii," the third tarsal joint, often also the second, present a proximally, oblique or perpendicular projecting process, from which long, stout, bristles project, and lie against the distal end of the chela, while the fourth joint, for the same purpose, on the whole ventral side appears more or less convex or flattened; also the third and fourth joints on both sides bear single, very long, stout bristles, which generally provide the chela with a support. The medial chela arm, which generally lies against the under-

side of the former, is composed of the fifth tarsal joint, which proximally is more or less elongated, only in some *Anteonini* is the fifth joint about normal, without elongation; on the ventral side, that is, on the side lying against the lateral chela arm, the median chela arm bears numerous rows of hyaline diversely shaped lamellæ and bristles. The lateral chela arm is slender, pointed, mostly saber-shaped, ventrally with or without rows of lamellæ and bristles, the medial chela arm usually so rests that both ends cross; there is presented a strong, lengthened claw; the other claw in contrast is reduced and wrapped around by the lobes of the more or less strongly lengthened empodium. If the fifth tarsal joint is much shorter than the proximal process, then both chela arms are movable, whereby the morphological proximal end of the fifth tarsal joint becomes apparently the distal end; in the contrary case only the lateral chela joint is movable. Abdomen slightly depressed from above, seldom laterally depressed together, second segment somewhat bell-shaped, the following gradually shorter and smaller.

Male: Generally the male is much smaller than the female, mostly only half as long, the eyes are pubescent and almost half spherical, while in the female they are bare and oval. The pronotum of the male is not visible from above, the hind angles of the prothorax reach the tegulæ always in the male, while in the female they often do not, the parapsidal furrows can be seen very plainly often extending across the mesonotum in the male, while in the female they may be lacking. In *Deinodryinus* the pterostigma is broad in the male and only moderately broad in the female, in two other genera the veins of the basal cells are obliterated in the male, while they appear well developed in the female, the legs of the male are not long and slender as in the female, but short and quite thick, the fore tarsus lacks the chela.

Key to Tribes of the *Anteoninæ*.

FEMALES.

1. Thorax divided by a deep constriction into two nodes, apterous, fore-tarsi with chela ....Tribe *Gonatopodini*
   Thorax not so divided, winged...2
2. Pterostigma small, lanceolate, female with chela.........Tribe *Lestodryini*
   Pterostigma broad...3
3. Wings with two basal cells, female with chela.............Tribe *Anteonini*
   Wings without basal cells, female without chela...........Tribe *Aphelopini*

MALES.

1. Pterostigma broad...2
   Pterostigma lanceolate...3
2. Wings with two basal cells...*Anteonini*
   Wings without basal cells..*Aphelopini*
3. Vertex angulate, head triangular in profile, ocelli generally widely separated..*Gonatopodini*
   Vertex rounded, head not triangulate in profile, ocelli not widely separated,
   Lestodryinini

Tribe *Lestodryinini*.

Dryininæ, Kieffer, Gen. Ins. fasc. 54 p. 3, 1907.
Lestodryinini, Kieffer, Das Tierreich, 416, 1914.

Female: Head mostly transverse; eyes long, strongly projecting; mandibles three or four dentate; antennæ slender. Pronotum mostly

not attaining the tegulæ. Wings present, with two or three closed basal cells, and a generally distally open radial cell; pterostigma small, lanceolate or linear-lanceolate; in two or three species the wings are rudimentary or shortened; fore legs strongly lengthened, coxa and the generally stalked and curved trochanter long, femur proximally strongly thickened, tibia distally thickened, first and fourth tarsal joints long, second, third and fifth short, the fifth always much shorter than its proximal elongation, forming with it the median chela arm, this always with rows of lamellæ, lateral chela arm often with rows of lamella or spines. The four hind legs more slender than the fore legs, coxa and trochanter much shorter, femur and tibia longer, first basally strongly thickened, the last distally slightly thickened; abdomen weakly depressed from above.

Male: Head transverse, vertex convex, ocelli situated close together in a triangle, seldom in an arc, eyes oblong oval, pubescent. Antennæ filiform, pubescent. Prothorax not visible from above, the hind angles attaining the tegulæ on the sides, mesonotum with or without parapsidal furrows. Wings with two basal cells; radius curved or angulate, the distal part generally as long or longer than the proximal, somewhat shorter in *Phorbas*. Pterostigma linear-lanceolate or small-lanceolate.

Genus *Phorbas* Ashmead.

Phorbas Ashmead, Bull. U. S. Mus., v, 45, p. 90 (♂), 1893.
Bocchus Ashmead, Bull. U. S. Mus., v. 45, p. 91 (♀), 1893.
Eukœbeleia Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 59, 1905.

Female: Head large, broad, vertex slightly convex, the sides converging behind the eyes; occiput very slightly concave, eyes large, oval; ocelli close together in a triangle, antennæ subfiliform, slightly thickened toward the tip, scape longer than first flagellæ joint. Maxillary palpi six-jointed, labial palpi three-jointed; mandibles three-dentate. Thorax normal, pronotum large, narrower than mesothorax. The hind angles attaining the tegulæ, parapsidal furrows distinct, somewhat converging, propodeum distinctly truncate. Wings present or rudimentary; if developed with lanceolate stigma, two basal cells, and an open marginal cell, the radius long and curved. Fore legs of medium length, fourth tarsal joint very long, but shorter than first; median chela arm not widened and provided with lamellæ but ventrally with continuous raised process; lateral arm ventrally dentate. Abdomen globose, distinctly petiolate, the petiole slender, cylindrical.

Male: Head broadly transverse, wider than thorax, vertex convex, eyes oblong oval, pubescent; longer than thorax. Maxillary palpi five-jointed, labial palpi three-jointed, mandibles three-dentate. Thorax with sparse short white hairs; mesonotum with two distinct parapdisal furrows. Wings hyaline, covered with fine white hairs and very shortly ciliated. Venation pale, pterostigma lanceolate, two basal cells and an open marginal cell, radial vein pale and curved, distally distinctly longer than proximally. Legs short. Abdomen subpetiolate, oval.

NOTE.—It has been suspected that *Phorbas* Ashmead was the male of *Bocchus* Ashmead and that *Eukoebeleia* Perkins was synonomous with the latter. The difference mentioned is that *Bocchus* has a four-jointed maxillary palpus while that of *Eukoebeleia* is five-jointed. Examination of Ashmead's type specimen of *Bocchus* showed that it had a five-jointed maxillary palp, and that the male of *Eukoebeleia* was synonymous with *Phorbas*. In Kieffer's key to *Bocchus* (1914) it is mentioned as having bare eyes. There is no note of this is Ashmead's description and those of his type were slightly hairy. Since the females of *Phorbas* have not been described it is impossible to include such species in the following key:

<div align="center">KEY TO SPECIES.</div>

1. Wings rudimentary ....3. *mirabilis*
   Wings developed...2
2. Scape as long as the third antennal joint, pronotum as long as the mesonotum..3
   Scape shorter than the third antennal joint, pronotum longer than the
      mesonotum..4
3. Prothorax yellow, head and mesonotum tinged with brown...1. *flavicollis*
   Prothorax black and most of body black........................5. *arizonica*
4. Third antennal joint almost twice as long as the first, abdomen reddish
      brown ....2. *atriceps*
   Third antennal joint but slightly longer than the first, abdomen black,
                                                                     4. *schafferi*

1. P. flavicollis (Ashmead).
   Bull. U. S. Mus., v. 45, p. 91 (♀). 1893.

Female: Black, except as noted, wings hyaline, with fuscous band across marginal cell, two-thirds width of wing. Length, 3 mm.

Marquette, Mich. Collected.

2. P. atriceps (Brues).
   Bocchus atriceps Brues, Canad. Ent., v. 36, p. 118 (♀), 1904, Kieffer. Das
      Tierreich 41 L p. 45, 1914.
   Chelogynus atriceps Brues, Bull. Wis. Soc. ser. 2 v. 3, p. 184, 1905.

Female: Reddish brown, head black above antennæ. Wings hyaline with fuscous band as in *flavicollis*. Length, 5 mm.

Moshola, New York. Collected.

3. P. mirabilis (Perkins). Plate I, Figs. 2 and 4.
   Eukœbeleia mirabilis Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 59, (♀) 1905.

Female: Dull red to black, in black specimens only posterior region of vertex dorsal part of prothorax and mesonotum dull red. Antennæ except two or three basal joints black; mandibles and legs yellowish-brown or testaceous, abdominal pedicel pale. Head and thorax densely minutely punctate, thorax and sides of head distinctly pilose. Propodeum rugose-areolate dorsally, posteriorly rugose with median area defined by raised lines and this bordered by a similar narrower area on each side. Wings rudimentary, pointed, the fore pair reaching beyond

posterior margin of thorax. Abdomen smooth, polished, posterior segments with scattered stout hairs. Length, 2.5–3 mm.

Male: Black, pubescent, tibiæ and tarsi of fore legs fuscous, tarsi of middle and hind legs, except fifth joint which is fuscous, testaceous or pale yellow. Head distinctly more than twice as wide as long, posterior margin arcuate, occiput concave. Ocelli in a triangle, the anterior one its diameter distant from the lateral ones which are much nearer to each other than to the eyes. Eyes oblong, oval, pubescent. Antennæ of medium length, pubescent, scape twice the length of three, this twice longer than two, very slightly longer than four, four to nine subequal, nine somewhat smaller than four, ten slightly longer than nine and pointed; clypeus arcuate, mandibles black except the brown teeth, maxillary palpi dark brown, long, extending beyond the posterior margin of the head, with three joints visible beyond the geniculation. Head and thorax densely punctate. Mesonotum broad, wider than long, with distinct parapsidal furrows which slightly converge and extend to the posterior margin of the mesonotum being widely separated there; scutellum much smaller than mesonotum being nearly square and only slightly wider than long; metanotum somewhat shorter than scutellum, posteriorly rounded; propodeum rugose-areolated, with median area defined by raised lines, wings hyaline, posterior wings ciliate, clothed with very fine white hairs. Venation pale, subcostal vein brown, radius curved, not reaching the wing margin, the distal part shorter than the proximal, pterostigma, lanceolate; brown, often white medianly. Legs of medium length. Abdomen polished black, with scattered stout hairs laterally and posteriorly. Length, 1.5–2 mm.

Described from two specimens. Columbus, Sandusky, Ohio. Bred from *Brucomorpha oculatus* adults.

4. P. schæfferi (Brues).

> *Chelogynus schæfferi* Brues, Bull. Wis. Soc., ser. 2 v. 5, p. 101 (♀), 1907.
> *Bocchus schæfferi*, Kieffer, Das Tierreich, 41 L. p. 45, 1914.

Female: Black; base of antennæ, mandibles and clypeus yellowish; prothorax, four anterior legs; coxæ and basal parts of femora of hind pair bright ferruginous. Frons and vertex rugulose, prothorax, mesonotum and scutellum, smooth and polished, with scattered punctures; scutellum with transverse crenulate impressed line at its base. Propodeum rugulose, the posterior face nearly smooth above. Abdomen shining black. Body conspicuously whitish pubescent except flagellum of antennæ. Length, 5 mm.

Huachuca Mountains, Arizona. Collected.

P. schæfferi Var. a. (Brues).

> *Chelogynus schæfferi* Brues, Bull. Wis. Soc., ser. 2 v. 5, p. 102 (♀), 1907.

Female: Colored like *P. atriceps* with entire thorax reddish, but structurally similar to above.

Brownsville, Texas. Collected.

5. P. arizonica (Perkins).

> *Eukœbelia arizonica* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 2, Bull. 4, p. 44
> (♀), 1907.

Female: Resembles *mirabilis*, but wings well developed, and raised lines on propodeum are more distinct. Length, 3 mm.

Nogales, Arizona. Bred from *Brucomorpha*.

Tribe *Gonatopodini*.

Gonatopodinæ, Kieffer, Andre, Spec. Hym. Eur., v. 9, p. 499, 1906.
Gonatopodini, Kieffer, Das Tierreich, 41 L, 1914.

Female: Head transverse or almost transverse, much broader than the thorax, dorsally mostly concave, seldom flat or slightly convex, posteriorly seldom rounded; the sloping surface of the posterior head concave. Eyes very large, almost occupying the entire side of the head, projecting outward, bare, posteriorly strongly diverging. Ocelli small and approximate, often indistinct or lacking. Maxillary palpus two to six jointed, labial palpus two or three jointed. Mandible slightly convex, three or four toothed. Antennæ originating close behind the clypeus, slender yet less so than in *Lestodryinini*, seldom reaching the hind end of the thorax, third joint the longest, the following gradually becoming shorter until the penultimate, the tenth somewhat longer than the preceding. Thorax strongly lengthened and of striking form, namely, divided by a generally pedunculate construction in a fore and a hind node, in one species asserted to be divided by two constrictions into three nodes. The fore node is composed of the prothorax and carries ventrally the fore coxæ; it is generally divided through a transverse furrow into two parts, of which the anterior is generally the shorter. The hind node bears ventrally the middle and the hind coxæ, and shows generally anteriorly a transverse suture, which continues itself laterally obliquely towards the posterior part and ends between the middle and the hind coxæ, this node is composed of the metathorax, the hind part of the mesothorax and the propodeum. The fore part of the mesothorax becomes formed through the nearly pedunculate construction, which is joined to the fore node, without forming a part of the same. Mesothorax and scutellum not visible, the latter often recognizable as a trace on the anterior part of the hind node. In *Gynochelys* the mesonotum and scutellum are distinct though quite small. Tegula and wings quite lacking, except in *Gynochelys* where the tegula is present and the wings replaced by a barely visible, scale-like process. Fore legs because of the divergent form of the thorax very widely separated from the middle legs, coxa and trochanter greatly lengthened, the latter generally proximally more slender than distally, also club-shaped femur and tibia shorter and thicker than those of the other legs, the femur proximally greatly thickened, the tibia distally and less strongly thickened, meta-tarsus and fourth joint of the tarsus long, the three other joints short, in *Cryprtogonatopus* the fourth joint is also short, median chela arm ventrally with rows of lamellæ; lateral chela

arm often with lamellæ, sometimes with rows of teeth, sometimes unarmed; middle and hind legs long and slender, femur in form of a reversed club, tibia straight and very thin, distally hardly thicker, claws simple. Abdomen slightly flatly compressed, in circumference mostly shortly oval, petiole short, second segment longer than third, this longer than any of the following.

Male: Head transverse, triangular viewed from the side, vertex angulate, ocelli not situated close together but generally widely separated. Eyes rounded, pubescent. Occiput deeply concave. Prothorax either not visible from above or barely so, the hind angles attaining the tegulæ on the sides; mesonotum with parapsidal furrows. Wings with two basal cells, radius curved or somewhat angulate, pterostigma lanceolate. The males differ from those of the *Lestodryinini* in the triangular head, angulate vertex, rounded eyes, and the arrangement of the ocelli.

Genus *Haplogonatopus* Perkins.

Haplogonatopus Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 39, 1905.

Female: Vertex distinctly and fairly deeply concave, mandible fourdentate; maxillary palpus two-jointed, third antennal joint the longest twice as long as the following one. Pronotum not divided by a transverse impression into two parts. Fore trochanter same length as coxa, fore femur twice as long as trochanter basally much swollen; chela reaching to the base of the third tarsal joint; median arm with two rows of lamellæ which are large, pointed and set far apart, and with a row of long spines, distally distinctly curved with a cluster of lamellæ at distal end; lateral arm nearly straight but distinctly curved and notched at its distal end, medianly with a row of lamellæ. First and fourth fore tarsal joints the longest, the first being somewhat the longer, the second and third much shorter, the second being the shortest.

Male: Head transverse, not wider than thorax, vertex angulate, occiput deeply concave; eyes large, rounded, finely pubescent; ocelli in triangle, the fore ocellus situated below vertex in a concavity twice its diameter in front of the lateral ocelli. These situated nearer to the eyes than to each other and directly on the hind margin of the head. Antennæ filiform, pubescent, scape one-third longer than two, three to six joints the longest, two less than half as long as three and somewhat swollen, seven to ten subequal, seven slightly shorter than three. Maxillary palpi not visible ventrally. Mandibles three dentate. Thorax pubescent, prothorax barely visible from above the hind angles attaining the tegulæ, mesonotum with two distinct posteriorly converging parapsidal furrows which are approximate on the posterior margin. Wings hyaline, finely haired and ciliated; venation distinct though pale, two basal cells and a nearly closed marginal cell, pterostigma narrow, radius distinct, long and curved almost extending to the wing margin. Legs long, especially the hind legs. Abdomen subpetiolate, oval. Five species of which one is North American.

H. americanus Perkins.

> *Gonatopus bicolor* Ashmead, Swezey, The Ohio Naturalist, v. III, p. 447–8
> (♀), 1903.
> *Labeo longitarsus* Ashmead, Swezey, The Ohio Naturalist, v. III, p. 447–8
> (♂), 1903.
> *Haplogonatopus americanus* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. I, p. 40
> (♀), 1905.

Female: Ferruginous to testaceous in color, abdomen black to brownish. Antennæ black, apical joint and two or three basal ones pale. Head nearly smooth, pronotum minutely punctured, propodeum dull with fine rugulosity. Length, 2.5 mm.

Male: Black, mandibles white, teeth brown, maxillary palpi white. Scutellum smooth and shining, metathorax posteriorly rounded, smooth and shining at top, but with lateral diagonal impressions separating punctate areas. Length, 2 mm.

Columbus, Sandusky, Ohio. Bred from *Liburnia campestris* and *L. lutulenta* nymphs and adults.

Genus *Gonatopus* Ljungh.

Gonatopus, Ljungh, Beitr. Naturk, v. 2, p. 161, 1810, Kieffer, Andre Spec. Hym.
 Eur., v. 9, p. 487 nota., 1906, Perkins, Rep. Exp. Sta. Hawaii, Ent. Bull. 11,
 p. 13, (non Perkins, 1905), 1912.
Dryninus, Dalman, Analecter ent., p. 14, 1823.
Neogonatopus Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 42, 1905.

Female: Head dorsally more or less slightly concave, maxillary palpus four-jointed, labial palpus two-jointed. Mesonotum and scutellum not visible. Fore tarsal joint, one and four long, the three others short; median chela arm distally bent inwards, ventrally with rows of lamellæ; lateral chela arm without lamellæ or teeth, at the most with a tooth before the distal end, often ventrally with rows of spines.

Male: Differs from *Haplogonatopus* chiefly in configuration of the head as follows: Concavity on the frons much smaller and vertex less angulate. There may be exceptions to this, however, as for instance, the male of *Gonatopus erythrodes* (Perk.). The maxillary palpus is four-jointed in comparison to that of *Haplogonatopus* which is two-jointed.

KEY TO SPECIES.

1. G. peculiaris Brues.

Trans. Amer. Ent. Soc. v. 29, p. 125 (♀), 1903.

Female: Polished black, except greater part of head, sutures of legs and base of antennæ, which are reddish or yellow. Pronotum smooth, shining, lacking the transverse impression. Length, 2.75–3 mm.

Austin, Texas.   Collected.

2. G. affinis n. sp.

Female: Differs from above chiefly in possessing the emargination on the pronotum. Dark brown to black, scape of antennæ white, mandibles and frons below antennæ testaceous, thoracic constriction, central area of hind node just before spiracles, and extreme posterior portion of propodeum yellow to testaceous. Legs ferruginous. Pronotum shining with minute punctures, thoracic constriction reticulately sculptured, hind thoracic node minutely reticulately rugose anteriorly and posteriorly, but smooth in middle. Abdomen polished, both abdomen and thorax with short scattered hairs. Length, 3.5 mm.

Male: Black, pubescent, vertex angulate, antennæ?* head triangular when viewed from side; vertex minutely and densely punctate; occiput deeply emarginate and excavated. Three ocelli visible from above, the anterior being below the vertex and twice its diameter distant from the lateral ones which are nearer to the eyes than to each other. Eyes nearly spherical, pubescent. Antennæ of medium length, pubescent. Mandibles white, teeth brown; maxillary palpi white, two joints visible. Prothorax scarcely visible from above attaining the tegulæ on the sides; mesonotum broad, with white pubescence very finely reticulately punctate; parapsidal furrows distinct, converging and meeting posterior margin of mesothorax but a small distance apart; scutellum much smaller than mesonotum, smooth and shining; propodeum minutely reticulately punctate. Wings hyaline, ciliated and clothed with fine hairs. Venation pale, pterostigma short and lanceolate. Two basal cells present. Radius pale, curved, the distal part much longer than the proximal, running almost to the margin of the wing, forming a nearly closed cell. Legs long, alternately marked with yellow and

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* Specimen imperfectly emerged.

brown. Coxæ and most of middle and hind femora brown, front femora light at ends and ventrally but brown otherwise, middle and hind tibiæ brown but yellow at distal and proximal ends, fore tibiæ yellow with brown band across middle, tarsi yellow, fifth tarsal joint brown. Abdomen fuscous, depressed dorso-ventrally, with fine whitish pubescence. Length, 2 mm.

Described from one specimen, Bay View, Ohio, bred from *Deltocephalus affinis*. Type deposited in Entomological Museum at Ohio State University.

3. G. cyphonotus Bradley.
Canad. Ent. v. 38, p. 380 (♀), 1906.

Female: Black, except scape, pedicel, face, mandibles, trochanters, all coxæ beneath, posterior and middle coxæ in middle, and anterior tibiæ and tarsi above, lemon yellow, rest of legs reddish yellow. Thorax above and abdomen smooth and polished, side of thorax thoracic constriction above, head and coxæ finely roughened; hump of thorax without transverse impression. Differs from *G. contortulus* in that entire thorax lacks fine transverse striation and that thoracic construction less marked. Length, 2.5 mm.

British Columbia. Collected.

4. G. bicolor Ashmead.
G. ashmeadi Kieffer, Andre. Spec. Hym. Eur. v. 9, p. 108, 1904.
G. bicolor Ashmead, Bull. U. S. Mus. v. 45, p. 85 (♀), 1893, Kieffer, Das Tierreich, 41 L. p. 73, 1914.

Female: Yellow or reddish yellow; 4–5 basal antennal joints yellow, rest brown. Middle and posterior knees and tips of posterior tibiæ black; abdomen piceous black. Mandibles four-dentate. Propodeum smooth, polished, posterior face slightly transversely aciculated. Length, 3 mm.

Silma, Alabama; Texas. Collected.

5. G. californicus Ashmead.
Bull. U. S. Mus. v. 45, p. 85, (♀), 1893.

Female: Piceous brown, except apex of metathorax and the abdomen, which are more or less black. Antennæ, tarsi slender part of posterior femora, and middle posterior tibiæ honey-yellow. Head finely and closely punctate, pubescent, metathorax transversely rugulose. Length, 3 mm.

California. Collected.

6. G. flavifrons Ashmead.
Bull. U. S. Mus. v. 45, p. 84, (♀), 1893.

Female: Black, shining, with fine shagreened punctation. Occiput, face, mandibles, palpi, antennæ except three terminal joints which are fuscous, and legs, yellow. Anterior femora above almost entirely black,

tibia with black streak above, middle and posterior coxæ and femora basally more or less black above. Comes nearest to *G. contortulus* but is larger, head broader, and differs in color. Length, 4.4 mm.

New York and Hull, Canada. Collected.

7. G. decipiens Provancher.
   Addit. Hym. Quebec, p. 179 (♀), 1897.

Female: Black, antennæ testaceous; tibia testaceous, fore tarsus brown, hind tarsi testaceous. Head large, flat, finely punctate, thorax smooth and shining. Length, 2.4 mm.

Kap Rouge, Canada. Collected.

8. G. contortulus Patton.
   Canad. Ent., v. 11, p. 65, (♀), 1897.

Female: Black; frons black to testaceous; scape and first flagella joint fuscous to pale testaceous; pronotum with central black area bordered by testaceous color laterally and on posterior margin. Anterior coxæ testaceous, brown at sides, anterior trochanter pale testaceous, anterior femora, tibiæ and basal two tarsal joints dark fuscous or dark testaceous, rest of tarsus and chela testaceous. Middle and hind legs fuscous to dark testaceous. Abdomen black or fuscous polished and sparsley haired. Prothorax faintly reticulately sculptured, mesonotum longitudinally rugose, propodeum finely reticulately sculptured anteriorly, posteriorly distinctly transversely rugose. Length, 3 mm.

Redescribed from four specimens. Sandusky, Ohio. Bred from *Deltocephalus sayi* adults.

9. G. punctatus n. sp.

Female: Similar to *G. contortulus* except as follows: pronotum distinctly and finely punctate; propodeum entirely and distinctly punctate and propodeum spiracles sessile. Thorax and propodeum without hairs. A distinct lateral, oblique suture separates the meso-and meta-thorax. Length, 3.5 mm.

Male: Black, pubescent; vertex angulate, head being triangular when viewed from side; occiput deeply hollowed out. Ocelli in triangle, all visible from above, the anterior not situated in a concavity. A very slight concavity on frons below anterior ocellus. Lateral ocelli nearer to the eyes than to each other. Eyes spherical, pubescent; antennæ nearly as long as the body and pubescent; two slightly shorter and thinner than scape and swollen at middle, three to six and ten, five times as long as wide, seven to nine successively becoming shorter, nine four times as long as wide. Mandibles, except the brown teeth, and maxillary palpi sordid yellow; latter short with two visible joints. Prothorax not visible from above, attaining the tegulæ on the sides, mesonotum finely sculptured. Parapsidal furrows converging for three-fourths their distance towards the base then becoming parallel and ending distinctly separated at the base; scutellum smooth and shining, being slightly wider than long. Metanotum somewhat wrinkled and somewhat shining, shorter than scutellum, posteriorly rounded;

propodeum roughened and densely and coarsely punctate, no area separated by raised lines. Wings hyaline, ciliated, clothed with short hairs. Venation distinct, pterostigma lanceolate. Radius curved proximally distinctly longer than distally but not reaching tip, sub-discoidal vein finely distinct and extending clear to margin of wing, cubital vein visible short distance from wing margin. Legs long, fore pair testaceous, last two pairs fuscous. Abdomen same length as thorax, black, pilose, depressed dorso-ventrally. Length, 2.4 mm.

Described from one male and three females. Columbus, Ohio. Bred from *Deltocephalus sayi* adults. Types deposited in Entomological Museum, Ohio State University. Paratypes in writer's collection.

10. G. ombrodes (Perkins).

> *Neogonatopus ombrodes* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 42 (♀), 1905.
> *Gonatopus ombrodes* Perkins, Rep. Exp. Sta. Hawaii, Ent. Bull. 11, p. 13, 1912.

Female: Black; vertex of head, and pronotum often piceous or brown, face and occiput yellow or ferruginous; basal two or three antennal joints pale; legs pale yellow brown or testaceous. Head and pronotum minutely punctate, propodeum dull and very densely sculptured. Abdomen smooth and glabrous. Length 3–3.4 mm.

Columbus, Ohio. Bred from *Deltocephalus* sp.?

11. G. mimus (Perkins).

> *Neogonatopus mimus* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 2, Bull. 4, p. 33 (♀), 1907.
> *Gonatopus mimus* Perkins, Rep. Exp. Sta. Hawaii, Ent. Bull. 11, p. 13, 1912.

Female: Ferruginous or testaceous, abdominal petiole black, abdomen often darker than the thorax or brown; first two or three antennal joints testaceous, rest black. Head in front of ocelli smooth, behind dull with minute sculpture, antennæ short and stout. Chela with fifth joint having lamellæ not reaching to articular cavity but replaced towards tip by bristles. Length, 2.5–3 mm.

Nogales, Arizona. Bred from jassid sp.

12. G. obscurissimus (Perkins).

> *Neogonatopus obscurissimus* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 43 (♀), 1905.
> *Gonatopus obscurissimus* Perkins, Rep. Exp. Sta. Hawaii, Ent. Bull. 11, p. 13, 1912.

Female: Black, pronotum, mesonotum, and some of leg joints dark brown or piceous. Basal 2–3 antennal joints, tarsi and part of hind tibiæ and femora pale, yellow, or testaceous. Head and pronotum shining, latter faintly sculptured; propodeum with minute dense surface sculpture, posteriorly finely transversely rugose. Length, 3 mm.

Columbus, Ohio. Bred from *Deltocephalus* spp.

13. G. inimicis n. sp.

Female: Nearest to *G. obscurissimus* but differing as follows: Head slightly concave, general body color fuscous, head smooth, without hairs mesothorax ferruginous, fuscous anteriorly, finely reticulately rugose, propodeum fuscous, polished, smooth posteriorly with fine indistinct punctation. Thoracic spiracles on elevations. Length, 2.75 mm.

Described from two specimens. Bay View and Columbus, Ohio. Bred from *Deltocephalus inimicus* adults. Type deposited in Entomological Museum, Ohio State University.

14. G. erythrodes (Perkins). Plate I, Figs. 1 and 5.

> *Neogonatopus erythrodes* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 43 (♀), 1905.
> *Gonatopus erythrodes* Perkins, Rep. Exp. Sta. Hawaii, Ent. Bull. 11, p. 13, 1912.

Female: Ferruginous; propodeum black, abdomen testaceous to brown; antennæ black, three basal joints pale; legs yellow-brown to testaceous. Head and pronotum shining, latter with fine indefinable punctation; propodeum dull, similar to *G. ombrodes* but posterior face distinctly transversely rugose. Length, 3 mm.

Male: Black, pubescent, vertex angulate, head being triangular when viewed from side; occiput deeply emarginate and excavated. Anterior ocellus situated in a concavity on the frons and not visible from above. Lateral ocelli nearer eyes than to each other. Eyes oval pubescent; mandibles testaceous, teeth brown. Maxillary palpi sordid white with two joints visible. Antennæ pubescent, of medium length being about same length as thorax, two shorter than one, three distinctly longer than one being three times as long as wide, four-nine subequal shorter than three, ten pointed and narrow, slightly longer than nine. Head and prothorax densely punctate, latter not visible from above, attaining the tegulæ on the sides; mesonotum broad, shining, minutely sculptured, parapsidal furrows converging being but narrowly separated at the base; scutellum nearly square, polished, with transverse furrow near the base; metanotum polished and half-length of scutellum; propodeum rugose. Wings hyaline, ciliated, and clothed with fine hairs. Venation pale, pterostigma elongate lanceolate. Two basal cells present. Radius curved, the distal part longer than the proximal, nearly reaching margin of wing. Legs long, fore legs testaceous, tip of femora and bases of tibiæ lighter color, last two pairs of legs fuscous; abdomen as long as thorax, black, pilose dorso-ventrally depressed. Length, 1.5 mm.

Described from one specimen. Sandusky, Ohio. Bred from *Deltocephalus inimicus* nymphs. Type of male deposited in Entomological Museum, Ohio State University.

15. G. mimoides (Perkins).

> *Neogonatopus mimoides* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 2, Bull. 4, p. 34, (♀), 1907.
> *Gonatopus mimoides* Perkins, Rep. Exp. Sta. Hawaii, Bull. 11, p. 13, 1912.

Female: Ferruginous or testaceous, petiole black, mandibles pale yellow. Antennæ black, three basal joints pale. Pronotum very

minutely punctate with sparse short hairs, thoracic constriction long; propodeum closely and minutely punctured, posteriorly transversely rugulose. Abdomen sparsely pilose. Length, 3 mm.

Nogales, Arizona. Collected.

16. G. brunnescens (Perkins).

> *Neogonatopus brunnescens* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 44, (♀), 1912.
> *Gonatopus brunnescens* Perkins, Rep. Exp. Sta. Hawaii, Ent. Bull. 11, p. 13, 1912.

Female: Brown or yellow-brown, abdomen dark brown to black, or sordid testaceous; propodeum posteriorly dark brown or pitchy. Basal two or three antennal joints and all legs pale colored. Head very little concave on vertex. Head and propodeum smooth, abdomen pilose. Length, 2.5–3 mm.

Columbus, Ohio. Bred from *Euscelis (Athysanus) curtisii.*

17. G. pallidiceps (Perkins).

> *Neogonatopus pallidiceps* Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 45, (♀), 1905.
> *Gonatopus pallidiceps* Perkins, Rep. Exp. Sta. Hawaii, Ent. Bull. 11, p. 13, 1912.

Female: Black; head, apical margin of pronotum, and the neck in front of it, three basal antennal joints, and all legs pale, yellow, or ferruginous. Head smooth, pronotum very finely punctured, propodeum with minute surface sculpture, posteriorly very finely transversely rugose. Abdomen deep black. Length, 2.5 mm.

Alameda, California. Collected.

Tribe *Anteonini.*

Anteoninæ, Kieffer. Andre, Spec. Hym. Eur., v. 9, p. 510, 1906.
Anteonini, Kieffer, Das Tierreich, 41 L, 1914.

Thorax not divided into two nodes by a constriction. Wings almost always developed, only atrophied in *Mystrophorus.* Pronotum attaining the tegulæ. Pterostigma broad, half ellipsoidal in shape, only small and elongate in *Deinodryinus;* venation composed of costa, subcosta, a radius not reaching the fore wing margin, medial, submedial, a basal vein originating at the distal end of the subcosta and a transversal vein, other veins obliterated, only visible as transparent lines. Fore-legs not strongly elongated and not excessively slender, coxa and trochanter short, fore tarsus with a chela in the female, lateral chela arm always without lamellæ.

Genus *Chelogynus* Haliday.

Gonatopus (part), Dalman, Svenska Ak. Handle, p. 81, 1818.
Dryinus (part), Dalman, Analecta Ent., p. 9, 1823.
Chelogynus Haliday, Ent. Mag., v. 5, p. 518, 1838.
Antæon (part), T. A. Marshall, Cat. Brit. Hym., Oxyura, p. 7, 1873.
Anteon (part), Kieffer, in Andre, Spec. Hym. Eur., v. 9, p. 130, 1905.
Neochelogynus and **Prosanteon** (part), Perkins, Rep. Exp. Sta. Hawaii, Ent. v. 1, p. 60, 66, 1905.

Distinguished from *Anteon* by the fourth joint of the front tarsus, which in the female is longer than the metatarsus, by the median chela arm, which is provided ventrally with rows of lamellæ and whose free distal end is as long or longer than the basal. As in *Anteon* the parapsidal furrows are at least lacking behind, the eye is bare, the radius mostly angled, the proximal part much longer than the distal.

KEY TO *Chelogynus.*

1. Wings hyaline...2
   Wings with one or two dark transversal bands..............................6
2. Antennæ brown..3
   Antennæ partly red or testaceous, at least the distal end black............4
3. Pronotum longer than mesonotum and coarsely punctate...........4. *osborni*
   Pronotum as long as the mesonotum and very finely punctate....3. *canadeniss*
4. Only the end joint of the antennæ black, the others testaceous........1. *lusus*
   Not only the end antennal joint black......................................5
5. Coxæ black for the greatest part, pronotum with rugulosities....9. *funestus*
   Coxæ pale ....2. *melanacrias*
6. Wings with one dark band, head and thorax red..............5. *atriventris*
   Wings with two dark bands...7
7. Entirely ferruginous ....6. *ferrugineus*
   Black...8
8. Frons with three longitudinal ridges, sides of face reddish brown..7. *grandis*
   Frons without longitudinal ridge, face black...................8. *henshawi*

1. C. lusus Perkins.
   Rep. Exp. Sta. Hawaii, Ent. v. 2, Bull. 4, p. 50, (♀), 1907.

Female: Black, head and pronotum densely minutely shagreened, mesonotum with fine surface sculpture, scutellum polished, propodeum rugose, posteriorly dull, with very dense and fine rugulosity. Mandibles white, antennæ except apical joint concolorous and testaceous. Length, 2 mm.

Tucson, Arizona.   Bred from jassid nymph.

2. C. melanacrias Perkins.
   Rep. Exp. Sta. Hawaii, Ent. v. 2, Bull. 4, p. 49, (♀), 1907.

Female: Differs only from *C. lusus* in color and sculpture as follows: antennæ testaceous on basal joints, four apical joints black. Pronotum somewhat transversely rugulose anteriorly. Length 2–2.5 mm.

Nogales, Arizona.   Collected.

3. C. canadensis Ashmead.
   Bull. U. S. Mus., v. 45, p. 93, (♀), 1893.

Female: Black; head finely punctate, pronotum as long as mesonotum very finely punctate, mesonotum and scutellum smooth, propodeum rugose. Length, 2.5 mm.

Ottawa, Canada.   Collected.

4. C. osborni n. sp.   Plate I, Fig. 6.
   Female: Black, antennæ brown, scape testaceous, flagellum brown except third flagellar joint which is dark brown, legs testaceous except middle and hind coxæ and trochanters which are fuscous, and distal end of hind femora which is darkened. Mandibles testaceous except teeth

which are brown, maxillary palpi pale testaceous with three joints visible. Ocelli in triangle, the anterior situated medianly on the vertex, the lateral ones closer together than to eyes and three times their diameter distant from the anterior. Eyes oval and bare. Antennae somewhat elbowed, the scape long, the flagellum slightly clavate, three two-thirds as long as one, more slender and twice as long as two, four shorter than three but longer than five, six to nine subequal twice as long as wide, ten slightly longer than nine and pointed. Vertex with few scattered very fine punctures, pronotum with few large punctures, longer than the smooth mesonotum. Parapsidal furrows distinct, extending half-way length of mesonotum, converging. Scutellum smooth, over half as long as mesonotum, with deep transverse furrow across anterior margin and a row of punctures across base. Metanotum half length of scutellum, shining with deep furrow across anterior margin. Propodeum distinctly reticulately rugose with middle rugulose area marked by raised lines. Median chela arm with two rows of lamellae distally which converge into a single row medianly, tip spoon-shaped with cluster of lamellae. Wings ciliated, clothed with fine hairs, with two basal cells, radius straight, the distal part very short and angled. Abdomen globose, shortly pedunculate, polished, black. Entire body pubescent, face thickly so, vertex and dorsal part of thorax with few scattered hairs, propodeum with numerous hairs, abdomen with few indistinct hairs. Differs from *C. canadensis* chiefly in character of antennae, and body sculpture. Length, 2.5 mm.

Described from two specimens. Sandusky, Ohio. Bred from *Chlorotettix unicolor* nymphs. Type deposited in Entomological Museum, Ohio State University. Paratypes in writer's collection.

5. C. atriventris (Cresson).

> *Dryinus atriventris* Cresson, Trans. Amer. Ent. Soc., v. 4, p. 193, (♀), 1872.

Female: Ferruginous, with pale pubescence. Face, mandibles, and base of scape pale yellowish; tips of antennae black, propodeum rugose, posterior face depressed and transversely aciculated. Length, 4.5 mm.

Texas. Collected.

6. C. (?) ferrugineus Brues.

> Bull. Wis. Soc., v. 3, p. 183, (♀), 1905.

Female: Ferruginous, except darker tips of antennae and tarsi, scape white at base below, mandibles yellow. Head rugose-punctate, prothorax finely punctured shining covered with short pubescence; mesonotum shorter, polished, with few punctures and distinct parapsidal furrows; propodeum finely reticulated; abdomen polished and unpunctured. Length, 5 mm.

Texas. Collected.

7. C. (?) **grandis** Brues.
Bull. Wis. Soc., v. 3, p. 184, (♀), 1905.

Female: Black, legs black except four anterior tibiæ and tarsi, base of anterior trochanters, and tips of anterior femora. Sides of face below and antennæ except five apical joints, rufous, mandibles black, maxillary palpi fuscous. Occiput shining, finely punctured, and sparsely pubescent. Prothorax strongly contracted; pronotum closely punctured; mesonotum polished delicately punctate; scutellum shining; propodeum finely rugulose. Length, 7 mm.

Riverside, Massachusetts.

8. C. (?) **henshawi** Ashmead.
Bull. U. S. Mus., v. 45, p. 93, (♀), 1893.

Female: Black; antennæ and legs pale rufous; the six terminal antennal joints fuscous; clypeus and mandibles rufous. Head and prothorax finely rugose; mesonotum and scutellum smooth; propodeum coarsely rugose. Wings hyaline with two transverse fuscous bands. Length, 5 mm.

Milton, Mass. Collected.

9. C. funestus Perkins.
Rep. Exp. Sta. Hawaii, Ent. v. 2, Bull. 4, p. 48, (oo), 1907.

Female: Black; basal four antennal joints ferruginous; front femora pale to black; mandibles yellow. Head and frons dull, minutely rugulose; antennal flagellum subclavate, pronotum with extremely fine transverse rugulosity; mesonotum with few shallow punctures; scutellum smooth and shining; propodeum truncate, rugose, posteriorly minutely rugulose without a definite central area. Length, 2-5 mm.

Male: Black; anterior tibiæ and tarsi testaceous, middle and hind tarsi pale or brown. Head sculptured as in female, antennæ as long as head and thorax, flagellum submoniliform, mesonotum with faint surface sculpture, scutellum polished; propodeum as in female. Length, 2 mm.

Tuscon, Arizona. Bred from jassid nymphs found on small bush.

Tribe *Aphelopini*.

Anteoninæ (part), Kieffer, Andre Spec. Hym. Eur., v. 9, p. 495, 1906.
Aphelopinæ, Perkins, Rep. Exp. Sta. Hawaii, Ent. Bull. No. 11, p. 7, 1912.
Aphelopini Kieffer, Das Tierreich, 41 L., p. 214, 1914.

Distinguished from the *Anteonini* as follows: Wings hairy and ciliated, with costa, subcosta, radius and a broad truncate pterostigma; the rest of the veins obliterated. Legs not thickened, fore legs without chela in ♀.

Genus *Aphelopus* Dalman.

Gonatopus (part) Dalman, Swenska A. k. Handl., p. 82, 1818.
Dryinus (Aphelopus) Dalman, Anatecta ent., p. 14, 1823.
Aphelopus Haliday, Ent. Mag., v. 1, p. 273, 1833.
Ceraphron (part), Ratzeburg, Ichneum, v. 2, p. 141, nr. 2, 1848.

Head transverse, anteriorly slightly narrowed, posteriorly deeply arcuate. Eyes almost reaching the hind margin, oval, with a short, scattered, indistinct pubescence. Ocelli forming a triangle, the lateral ones nearer the hind edge than to the eye, farther apart than from the eye. Mandible twice as long as broad, distally truncate and three-dentate, the teeth three-angled, of equal length, the middle often with a little tooth at its base. Maxillary palpus with fine long joints, labial palpus two or three jointed. Antennæ originating close or the clypeus and farther apart than from the eyes, pubescent. Pronotum barely visible from above; mesonotum convex, transverse, anteriorly rounded, with two posteriorly converging parpasidal furrows extending only part way down the mesonotum, seldom without such. Scutellum posteriorly rounded, anteriorly with a transverse impression; propodeum large, at first horizontal, then gradually sloping; propleura concave; mesopleura strongly convex, with an oblique longitudinal furrow, separated from the metapleura by a ridge reaching from the wing bases to the hind edge of the middle coxæ. Venation as above given. Hind wings without distinct veins, with four frenula. Spur of fore tibia hairy, narrowed on the whole ventral side to a base, hyaline lamella, which is discontinued suddenly before the distal end of the spur, this thus appearing two-lobed, all claws simple. Abdomen strongly laterally compressed, as long or shorter than the thorax.

KEY TO SPECIES OF *Aphelopus*.

1. Thorax without white color...2
   Thorax in part white, at least first two pairs of legs white or pale yellow..10
2. Radius very short one-third as long as the pterostigma, abdomen reddish
   brown ....1. *rufiventris*
   Radius at least as long as the pterostigma, abdomen black............ ...3
3. Propodeum with a smooth median field, head without red coloring... ...5
   Propodeum without a medium field....................................4
4. Face, clypeus, mandible and genæ ferruginous.....................2. *affinis*
   Face white to just above bases of antennæ.. ....9. *comesi*
   Face black ....3. *dikraneuri*
5. Mesonotum smooth and shining........................5. *americanus*
   Mesonotum dull and coriaceous........... 6
6. Head with mandibles above white... . .. .7. *arizioncus* (♀)
   Head with white facial markings.....................................7
7. Clypeus alone white ....4. *microleucus*
   More than clypeus white...8
8. White facial markings extending a little above the antennæ....8. *viduus*
   White facial markings extending at least as far as the anterior ocellus,
   along the eye margins...9
9. Mesonotum densely minutely shagreened...............7. *arizonicus* (♂)
   Mesonotum coriaceous ....6. *varicornis* (♀)
10. Only pronotum and prosternum white, the rest of the thorax black......
    10. *albopictus*
    Mesonotum, except middle section, pleura, and sternum white. ......
    11. *pulcherrimus*

1. A. rufiventris Ashmead.
    Bull. U. S. Mus., v. 45, p. 100, (♀), 1893.

Female: Head and thorax black, minutely punctate; abdomen rufous; antennæ and legs honey yellow. Antennæ short, subclavate. Propodeum coarsely rugose. Length, 2 mm.

Jacksonville, Florida. Collected.

2. A. affinis Ashmead.
    Bull. U. S. Mus., v. 45, p. 102, (♀), 1893.

Female: Black, face from frons ferruginous; antennæ brown; legs except posterior tibiæ which are fuscous, honey yellow. Head and thorax minutely punctate, propodeum rugulose. Length, 2.2 mm.

Canada. Collected.

3. A. dikraneuri n. sp. Plate I, Fig. 3.

Black; clypeus ferruginous, mandibles yellow, maxillary palpi long, white, extending beyond the base of the head with four segments visible. Legs fuscous to brown; fore legs may be testaceous, if so coxæ are fuscous. Antennæ brown entirely. Ocelli in triangle, the anterior located medianly on the vertex and farther from the lateral ones than they are from the hind margin of the head, these nearer to the eyes than to each other. Eyes oval, without hairs. Antennæ filiform, two same length and width as one in male, both wider than three; one somewhat longer than two in female; four-nine equal in length three times longer than wide, ten distinctly longer than nine, tapering at tip. Vertex and mesonotum minutely reticulately sculptured. Parapsidal furrows distinct, converging and extending half way the length of the mesonotum in male, shorter and not extending to middle in female. Scutellum finely reticulately sculptured, metathorax smooth and shining, propodeum reticulately rugose without median smooth area. Radius slightly curved and part beyond usual point of angelation obliterated. Abdomen compressed laterally. Head and thorax pubescent, abdomen with numerous hairs on ventral half of side and posteriorly. Length, 1.5 mm.

Columbus, Ohio. Bred from *Dikraneura fieberi*, adults. Described from one male and three females. Type deposited in Entomological Museum, Ohio State University. Paratypes in writer's collection.

4. A. microleucus Perkins.
    Rep. Exp. Sta. Hawaii, Ent. v. 2, Bull. 4, p. 55, (♀), 1907.

Male: Black; clypeus and mandibles white, two basal antennal joints dark brown, all coxæ and trochanters pale yellowish white or white, front legs testaceous; middle legs darker, and hind legs black. Head and thorax minutely sculptured, propodeum reticulately rugose, small smoother area on posterior face. Antennæ filiform. Length, 2 mm.

Nogales, Arizona. Bred from *Erythroneura* sp.

5. A. americanus Ashmead.
> Bull. U. S., Mus. v. 45, p. 100, (♀), 1893.

Male: Black; antennæ reaching to middle of abdomen; brown except scape which is yellow. Legs honey yellow, posterior femora and tibia fuscous or black. Finely punctate, except mesonotum and scutellum which are smooth with few indistinct scattered punctures. Length, 1.5 mm.

Jacksonville, Florida.   Collected.

6. A. varicornis Brues.
> Bull. Wis. Soc., v. 4, p. 143, (♀), 1906.

Female: Black; legs and first two antennal joints light yellow; face below ocelli and maxillary palpi white. Head finely shagreened, shining; mesonotum shagreened. Parapsidal furrows distinct extending two-thirds the length of mesonotum. Propodeum rounded behind, areolated and rugulose. Radius a little longer than stigma, faintly curved at tip. Length, 1.75 mm.

Woods Hole, Massachusetts.   Collected.

7. A. arizonicus Perkins.
> Rep. Exp. Sta. Hawaii, Ent. v. 2, Bull. 4, p. 53, (♂♀), 1907.

Female: Black; basal two antennal joints yellow or yellow-brown, legs testaceous, except hind femora and tibiæ which are black or pitchy. Head and mesonotum finely shagreened, antennæ sub-clavate, propodeum finely reticulately rugose, posteriorly with smooth shining area.

Male: Similar. Two basal antennal joints darker brown, face yellow below, legs entirely testaceous, antennæ more elongate. Length, 2 mm.

Nogales, Arizona.   Bred from *Dikraneura* sp.

8. A. viduus Perkins.
> Rep. Exp. Sta. Hawaii, Ent., v. 2, Bull. 4, p. 54, (♀), 1907.

Male: Black, lower part of face and mandibles pale yellow or cream-colored. Front and middle legs pale yellow, tarsi infuscate, hind femora, tibiæ, and tarsi, pitchy. Head and mesonotum densely shagreened. Antennæ long, slender and filiform. Propodeum reticulately rugose, a postina median area present. Length, 2 mm.

Nogales, Arizona.   Collected.

9. A. comesi n. sp.

Male: Black, face white to just above bases of antennæ. Mandibles, palpi, and short antennæ brown, the basal two joints testaceous. Fore legs, coxæ and trochanters of middle and hind legs and femora of middle legs white, tibiæ of middle leg darkened, femora and tibiæ of hind legs fuscous, tarsi of middle and hind legs sordid yellow. Abdomen brown. Head finely coriaceous shining, clypeus truncate. Eyes oval with fine, almost invisible pubescence. Antennæ filiform, three shorter than four,

which is shorter than five, seven and eight almost equal, slender, longer than four or five, more than twice as long as wide, ten long, slender. Head dull, finely coriaceous, mesonotum coriaceous with indistinct parapsidal furrows, converging and being obliterated slightly beyond the middle and almost indistinguishable anteriorly. Propodeum without median field and distinctly rugosely sculptured. Wings hyaline, radius pale, curved extending nearly to margin of wing. Abdomen with sparse hairs, smooth. Length, 1.5 mm.

Described from one specimen. Columbus, Ohio. Bred from *Erythroneura comes*, adult. Type deposited in Entomological Museum, Ohio State University.

10. A. albopictus Ashmead.
Bull. U. S. Mus., v. 45, p. 101, (♀), 1893.

Black, face below front ocellus, maxillary palpi, anterior and middle legs, pronotum to tegulæ, and propectus white or yellow-white. Antennæ dark brown. Head finely punctulate, propodeum rugose. Length, 1.5 mm.

Washington, D. C., and Bladensburg, Md. Collected.

11. A. pulcherrimus Perkins.
Rep. Exp. Sta. Hawaii, Ent., v. 2, Bull. 4, p. 54, sex? 1907.

Sex?: Black, whole face white, scape, legs white or pale yellow, mesonotum exteriorly to the parapsidal furrows, whole thorax beneath and pleural portion, cream colored. Antennæ except scape testaceous. Head and thorax densely shagreened, posterior area of metanotum minutely shagreened. Length 1.5 mm.

Nogales, Arizona. Bred from *Erythroneura* sp.?

THE DIGESTIBILITY OF SOY BEAN MEAL BY MAN.*

By J. F. Lyman and W. G. Bowers,

There always has been considerable interest, in connection with human nutrition, in the seeds of the legumes. The common white or navy bean has played a prominent part in the affairs of the United States in supplying nourishment to soldiers in the service and to laborers on the farm and in the factory. The bean has been recommended as the "poor man's beefsteak," supplying as does meat, large quantities of proteins.

In China and Japan another legume, the soy bean, is extensively used as human food. This is ordinarily prepared for the table by processes not in general use in this country, usually involving some kind of fermentation. These preparations supply a very important part of the food requirement, especially of the protein requirement, of the Chinese and Japanese, and have been found to be well utilized in the body, in some cases 96 per cent of the protein being absorbed.[1]

The soy bean has been cultivated rather extensively in the United States in recent years, but it has been used almost entirely as forage or for animal feed. Recently a soy bean meal, a by-product in the manufacture of soy bean oil, has been produced in considerable amounts in some sections of the South. The composition of this material and of the whole beans in comparison with common white beans suggests that we have here valuable supplies of human food which should not be neglected. The following table gives the average composition of the different materials.

	Moisture Percent	Protein Percent	Fat Percent	Fiber Percent	N-free Extract Percent	Ash Percent
[2]White beans (dry)...	12.6	22.5	1.8	4.4	55.2	3.5
[3]Soy beans.........	10.0	38.29	14.89	4.64	26.64	5.54
Soy bean meal.......	5.7	46.66	5.1	5.5	32.3	5.75

Obviously, chemical analyses alone do not measure the nutritive value of food. We must know also the digestibility of the food, the relative quality of its proteins, carbohydrates, fats and minerals, the extent to which accessory substances or vitamines occur, and finally whether, for any reason, it exerts a harmful influence on the body.

Mendel and Fine[4] found the protein in mush prepared from soy beans to be from 74.5 to 87.6 per cent digestible by dogs and 85.3 per cent digestible by men (uncorrected values). In fact the protein of soy beans was only 2.6 per cent less digestible than was the protein in a mixed diet of wheat, meat, eggs and peanut butter. The protein of the common white bean, baked in the usual way, was distinctly less digestible, viz., 77.9 per cent, in the human subject. The experiments of Wait[5] on the digestibility of white beans agree with this result. Daniels and Nichols,[6] from experiments on rats, have concluded that the proteins of the soy bean are highly efficient in promoting the growth of young animals, in fact, about as efficient as casein of milk. On the other hand, the proteins of the white bean appear to be decidedly poorer in quality or about as valuable as the proteins of corn.[7] Osborne and Mendel[8] found in soy beans abundant amounts of water-soluble accessory or vitamine, while the fat-soluble vitamine, though not abundant, appears to exceed the amount found in other seeds and grains commonly used for human food.

The nutritive quality of the white bean is further lowered by the presence of considerable amounts of carbohydrates, *e. g.*, hemicelluloses, which are indigestible in man, and which ferment in the intestine with the production of large quantities of gas, resulting in discomfort and even in injury to the intestine because of the stretching effect of the gas.[7] The carbohydrates of the soy bean, while resembling those of the white bean, appear to be considerably more digestible and less prone to intestinal fermentation. Mendel and Fine[4] in comparable experiments with dogs, fed in one case soy bean flour and in the other a preparation made from hulled white beans, and found five times as much fiber and over three times as much hemicellulose in the feces of the white bean fed animal. In the human subject the weight of the air dry feces from the soy bean feeding was increased only four per cent above the mixed diet period, while on the white bean diet the increase in weight of air dry feces was 68 per cent, indicating a good utilization of the non-nitrogenous material in the first case and a poor utilization in the second. In our own experiments the liberal use of soy bean meal in the diet, 120 grams per day for a three-day period, did not result in voluminous stools, on the contrary, both the protein and carbohydrates (N-free extract) of the soy bean meal was highly digestible, as will appear from the following experiment.

EXPERIMENT I.

The subject was a healthy man, aged 38, weight 150 pounds, engaged in moderately active laboratory work each day. Since, obviously, it is impossible to consume with relish an exclusive diet of soy bean meal, a mixed diet was selected containing a few articles of known digestibility in addition to soy bean meal, the chief constituent. The feces from the three-day experimental period were marked off with lampblack taken with the appropriate meals. Soon after collection of the stools they were moistened with alcohol containing a little sulphuric acid, dried on the steam bath, brought to an air-dry condition by exposure to the atmosphere of the laboratory and finely ground. Protein was determined by the Kjeldahl method (N x 6.25); fat by the method of Gephart and Csonka,[9] nitrogen-free extract, fiber and ash by the ordinary routine methods.[10]

The soy bean meal used in this experiment had the following composition:

Moisture	6.5	percent
Ash	5.7	"
Protein	44.1	"
Crude Fiber	5.9	"
Fat	3.3	"
N-free Extract	35.5	"

Two hundred grams of this meal were mixed with 400 grams of patent wheat flour and 10 grams of sugar and made into yeast-raised bread. This bread was of good texture and highly palatable.

The diet for the three days was as follows, approximately one-third being consumed each day.

	Grams	Protein Grams	Fat Grams	N-free Ext. Grams	Calories
Soy bean meal	200	88.2	6.6	71	696
Patent wheat flour	400	53.2	6.0	288	1420
Milk	3000	103.1	126.0	141	2064
Butter	200	.....	170.0	...	1530
Cane sugar	200	.....	.....	200	800
Total	4000	244.5	302.6	700	6510
Per Day	1330	81.5	100.8	233	2170

The feces from the three days weighed 248 grams moist, and 66.6 grams air-dry. They contained:

	Percent	Grams
Moisture	7.25	4.82
Ash	19.70	13.12
Protein	27.66	18.82
Crude fiber	8.46	5.63
Fat	22.01	14.65
N-free extract	15.22	10.14

In addition to undigested food residues, feces always contain nitrogenous metabolic products derived (1) from the digestive fluids and (2) from mucous and epithelial cells from the walls of the digestive tract. In order to determine the amount of these metabolic products a basal ration consisting of milk, butter, sugar, starch and agar, and designed to yield feces of about the same bulk as in the soy bean period was eaten. The diet was as follows:

    3000 grams milk
     275 grams butter
     150 grams cane sugar
     130 grams potato starch, boiled in water to make a pudding.
      36 grams agar, eaten dry and raw.*

One-third of the above was consumed daily for a three-day period. The resulting feces weighed 270 grams moist, and 55.6 grams air-dry, and contained:

	Percent	Grams
Moisture	5.36	2.98
Ash	19.50	10.85
Protein	11.90	6.60
Fat	31.20	17.34
Crude fiber	1.40	.77
N-free extract	30.60	17.03

The protein in the feces of this period represents metabolic products from the digestive juices and intestinal walls as well as some unabsorbed protein from the milk. Deducting this from the protein eliminated in the feces during the soy bean period we have $18.82 - 6.60 = 12.22$ grams, which represents the unabsorbed protein from the wheat flour and soy bean meal. This gives a coefficient of digestibility for the total protein of the bread of 91.3. Assuming that protein of patent wheat flour is 88.6[11] per cent digestible the coefficient of digestibility of the soy bean meal protein becomes 93. This is hardly fair, however, since the coefficient 88.6 was obtained without making a cor-

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* The agar contained 6.35 percent of ash and 15.75 percent of moisture.

rection for metabolic products in the feces. We feel safe in concluding, however, that soy bean meal prepared as in this experiment is as digestible as regards its protein as is the protein of fine wheat flour which stands supreme among the cereal grains in this respect.

The carbohydrates of bread made from fine wheat flour are 97.7 per cent absorbed in man,[11] milk sugar 99[12] per cent and cane sugar probably 100 per cent. Using these values the nitrogen-free extract of the soy bean meal is found to have a coefficient of digestibility of 96.9 per cent.

EXPERIMENT II.

In this experiment the soy bean meal was prepared as a porridge by cooking five hours in a double boiler. This sample of meal contained more grit than that used in Experiment I, but not enough to increase the ash content greatly. It had the following composition:

	Percent
Moisture	4.17
Ash	5.80
Protein	49.31
Crude fiber	5.10
Fat	6.50
N-free extract	29.12

The diet for the three-day period contained the following, approximately one-third being eaten each day:

	Grams	Protein Grams	Fat Grams	N-free Extract Grams	Calories
Milk	2000	70	80	94	1376
Butter	150	...	127.5	...	1147
Cane sugar	300	...	...	300	1200
Soy bean meal	370	182	24.0	108	1375
Total	2750	252	231.5	502	5098
Per Day	917	84	77.2	167	1699

The fecal residue from this food weighed 224 grams moist and 58.1 grams air dry and contained:

	Percent	Grams
Moisture	4.40	2.56
Ash	20.64	11.19
Protein	39.90	23.20
Crude fiber	7.00	4.06
Fat	18.96	11.00
N-free extract	9.00	5.22

Assuming that 6.06 grams of protein represents the unabsorbed protein of the milk plus the metabolic protein from the digestive fluids, etc., an assumption that can not be far from the truth, then the unabsorbed protein from the soy bean meal must be $23.20 - 6.60 = 16.60$ grams. This gives a coefficient of digestibility for the protein of the soy bean meal of 90.9. If the carbohydrates of milk are 99 and cane sugar 100 per cent absorbed then the coefficient of digestibility for the nitrogen-free extract of the soy bean meal is 96. In this experiment, as in Experiment I, we cannot calculate accurately the digestibility of the fat but we were not particularly concerned with that phase of the subject at this time. By adopting the proper experimental procedure one might determine satisfactorily the digestibility coefficient of soy bean fat, but for that purpose the amount of the experimental fat should be largely increased while other fats in the diet should be reduced to a minimum.

Summary: The protein of soy bean meal, prepared as a bread by mixing with wheat flour or as a porridge, is highly digestible by man. The digestibility factors obtained in the two experiments were 91.3 and 90.9.

The carbohydrates of soy bean meal appear to be much more highly digestible and less prone to intestinal fermentation than are the carbohydrates of the common white bean. The digestibility factors obtained in two experiments were 96.9 and 96.

The chemical composition, digestibility and palatability of foods prepared from soy bean meal from which most of the oil has been expressed, indicate that such a meal is an excellent food for man.

REFERENCES.

1. Oshima, Bul. 159 (1905), U. S. Dept. Agr. Office Exp. Stations.
2. Bul. 28, U. S. Dept. Agr. Office Expt. Stations.
3. Street and Bailey, J. Ind. Eng. Chem. 7, 853, (1915).
4. Mendel and Fine, J. Biol. Chem., 10, 447, (1914).
5. Bull. 187, U. S. Dept. Agr. Office Expt. Stations.
6. Daniels and Nichols, J. Biol. Chem., 32, 91, (1917).
7. McCollum, Simmonds and Pitz, J. Biol. Chem., 29, 521, (1917).
8. Osborne and Mendel, J. Biol. Chem., 32, 369, (1917).
9. Gephart and Csonka, J. Biol. Chem., 19, 521, (1914).
10. Bul. 107, U. S. Dept. Agr. Bureau Chem.
11. Report Maine Expt. Station, 1898.
12. Farmers Bul. 363, 22.

TABLE OF CONTENTS

THE PARASITES OF LEAF-HOPPERS.
With Special Reference to Anteoninæ.

F. A. FENTON.

PART III.

THE EFFECT OF PARASITISM ON THE HOST.

There has been comparatively little work done in regard to the internal or cytological changes in the insect host brought about by its parasite. Giard (1889) in working out the biology of *Aphelopus melaleucus* parasitic on *Erythroneura (Typhlocyba) hippocastani*, misinterpreted the real nature of the larval sac, supposing that it was a true animal gall, "formed by a gradual dilation of the hypodermis which secretes an abnormal cuticle * * * " He proposed the name *thylacies* to those galls produced in animals comparing the typhlocybid larval sac with the tumors caused by Cuterebra on the skin of mammals. He compared the genitalia of normal and parasitized *E. hypocastani* and *E. douglasi*. In the females of these two species the ovipositor in parasitized individuals is greatly reduced and functionless. In the males of *E. douglasi* very little change is brought about in the penis which is comparatively simple, but in *E. hippocastani* where this structure is a very complex eight-branched organ it is reduced to six or even three branches, thus greatly affecting the specific characters. Because of this superficially it might be confused with *E. rosæ*. Certain accessory sex organs were also found to be affected by the dryinid.

Marchal (1897) studied in detail the pathological conditions that *Trichacis remulus* Walk. produced in its host *Mayetiola destructor*, the Hessian fly. He observed that the *Trichacis* larva is always in intimate connection with the nervous system of the cecidomyid larva and he noted the remarkable cell proliferations that are brought about by the parasite. Although he did not find the early stages and therefore was unable to state anything about their origin, he made some striking conclusions, saying that "These groups of giant cells are evidently destined to accumulate nutritive materials necessary for the parasite. They are a kind of internal animal gall developed by the presence of the Hymenopteron."

Keilin and Thompson (1915) noticed the peculiar mass of hypertrophied tissue formed within *Erythroneura hippocastani* parasitized by *Aphelopus melaleucus* and traced its origin to the hypodermal cells which are stimulated to abnormal growth by the presence of the parasite. The early stages of the dryinid were found to be enclosed by this tissue similar to that in the *Trichacis* larva, shutting the parasite off from the viscera of the host. This cyst was noticed to be surrounded by a membrane which persisted after the parasite larva had assumed the curved position and had broken through to the exterior of the host. They believe that the parasite draws its nourishment from its host through the cyst membrane until the fifth stage is reached, and that the tissue is not a phagocytic cyst. They compare the cyst to the placenta in animals or to a vegetable gall and term the parasitism "*placentaire*" or "*gallicole*."

Kornhauser (1915-16) in studying the effects of *Aphelopus* parasitism on *Thelia bimaculata* observed marked changes in the external characteristics of the sexes, especially in the size and form of the male and a reduction of the external genitalia of both sexes, stating that "the presence of parasites in the male nymph brings about lower oxidation, storing of fat, retarded rate of development, increased size; and with this change in metabolism comes a change in some of the secondary sexual characters. But changed metabolism is not powerful enough to change the external genitalia, it merely reduces them in size."

In studying the effects of the parasitism of *Aphelopus comesi* on *Erythroneura comes* the writer was able to confirm many of Keilin and Thompson's observations and to add a number of interesting points. The early phases were not studied

owing to a lack of material, but comparisons of the later stages
of parasitism in these hoppers with normal individuals were
made.   When the dryinid is in its second instar and has become
partly external the hypertrophied tissue has reached its maxi-
mum size (Plate II, Fig. 2).   It is seen as a large ovoid mass
of cells occupying most of the body cavity in the hind thoracic
and anterior abdominal regions, displacing and pushing back-
wards the large storage stomach of the host.   It extends for
three somites as a rule, its anterior extremity lying between the
muscles of the third thoracic segment.   It is in intimate con-
nection with the point of attachment of the parasite.   In
cross section the thin membrane surrounding it can be seen,
except at that part nearest the parasite, where the cells of the
cyst are in contact with the mouth parts of the latter, (Plate
IV, Fig. 3).

In the earliest stages studied the cell walls and nuclei are
sharply defined and part of the tissue is composed of dividing
cells, (Plate IV, Fig. 2; Plate VI, Fig. 1).   The cells are filled
with food globules and are vacuolated.   Later division ceases
and the cells become more noticeably vacuolated, (Plate IV.,
Figs. 3 and 4).   Late in the fourth instar of the parasite dis-
integration of the cells begins, (Fig. 5, Plate IV, Figs. 3 and 4).
The cell walls are broken down, the nuclei become disintegrated
and the protoplasm becomes very largely filled with round
vacuoles.   Directly after the fourth molt of the parasite this
cyst is attacked first and devoured after which the host viscera
are devoured.

The cyst stains easily with Delafields haemotoxylin, being
thus sharply contrasted with the surrounding tissues which
take the eosin stain more readily.   It reacts to stains similarly
and resembles fatty tissues.

The function of such a cyst is problemmatical.   It is not
found in a great many other insect hosts of *Hymenopterous*
parasites and has not been observed in any other genus of the
Anteoninæ so far.   It cannot be phagocytic because the mandi-
bles of the parasite are not developed or are functionless until
the last larval molt, and it is not absorbed.   Except for cyto-
plasmic changes it remains unchanged until the fifth instar is
reached by the dryinid.   It doubtless serves as a means for
absorbing, storing up, and then in turn giving up in a modified
manner food for the parasite that otherwise would have been
utilized by the host.   This food is probably absorbed from the
blood of the hopper through the cyst membrane.

This hypertrophied tissue is developed principally at the expense of the gonads of the host, (Plate III, Figs 1 and 2). These are lacking or almost so in parasitized individuals. The digestive system is also modified to some extent in that the storage stomach is forced backwards and displaced by the abnormal tissue.   The malpighian tubules are much smaller in parasitized individuals.   Normally these are large and much swollen, in parasitized specimens they are hardly enlarged at
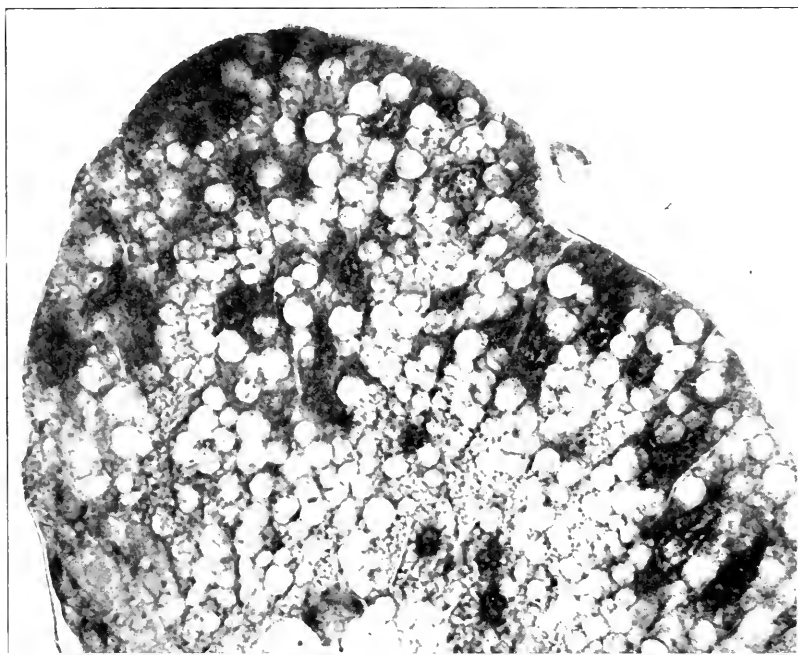
Text Fig. 5.   Hypertrophied tissue in dryinized male *Erythroneura comes* (high power).

all.   When the parasite pushes apart the abdominal somites and begins to grow outwards the cavity thus formed in the body wall is enlarged until it becomes almost circular. Around this cavity a layer of hypodermal cells is developed as an abortive response by the host tissues to heal over the wound, (Plate IV, Figs. 2 and 4).

No other host was studied in as much detail in regard to the cytological changes as was the above.   However it is certain that in the case of *Gonatopus contortulus* parasitic on *Delto-cephalus sayi*, (Plate VI, Fig. 2), there is no such development and from general dissections of all the other species studied in

this paper no such tissues were found.   Since many Cicadellid species are attacked and parasitized by dryinids after they have become sexually mature it is doubtful in these cases whether the gonads would be completely disintegrated.   In fact in parasitized *Deltocephalus sayi* they are present, but modified in that the germ cells are not matured after a certain point is reached in the parasites growth, so that if reproduction is not entirely stopped it is greatly impaired.

In *Erythroneura comes* the hypertrophied tissue is probably caused by a stimulation set up by the presence of the parasite in the host's tissues or to some toxic substance secreted by it. That the sting alone will not produce such a result is proved by the fact that hoppers that have been stung but not oviposited in develop and mature in a perfectly normal manner.

A comparison of the genitalia of both sexes in *Erythroneura comes* in normal and parasitized individuals showed no differences.

CONCLUSIONS.

1.   The larva of *Aphelopus* species secretes some toxic substance into the tissues of the host or otherwise stimulates the abnormal development of the hypodermal tissues into a hypertrophied cell mass.

2.   This is developed at the expense of the gonads which do not develop upon the maturity of the host.

3.   This is surrounded by a membrane and functions as a means of absorbing food from the body of the host for the parasite and is itself not consumed until just before the death of the host.

4.   The genitalia of the host are not modified by the parasite.

5.   A wall of cells is developed around the wound produced in the body wall of the host.

6.   The malpighian tubules of the host are underdeveloped.

7.   *Gonatopus, Haplogonatopus,* and *Chelogynus* species that parasitize nymphs stop further development of the host which does not become mature.

8.   Adults parasitized by these genera, that have become sexually mature, may still reproduce at first but there are evidences that soon reproduction is greatly impaired or entirely stopped.

9.   The hypertrophied tissue has not been found produced by any genus other than *Aphelopus.*

BIBLIOGRAPHY.

ASHMEAD, W. H.—Monograph of the North American *Prototrypidæ*. Bulletin U. S. National Museum, 45, pp. 80-102, 1893.

BRUES, C. T.

———Descriptions of New Ant-Like and myrmecophilous *Hymenoptera*. Transactions American Entomological Society, Vol. 29, p. 125, 1903.

———Some New Species of Parasitic *Hymenoptera*. Canadian Entomologist, Vol. 36, pp. 117-119, 1904.

———Notes and Descriptions of North American Parasitic *Hymenoptera*. Wisconsin Natural History Society, Vol. III, pp. 183-185, 1905.

———Notes and Descriptions of North American Parasitic *Hymenoptera*, Number 11, Wisconsin Natural History Society, Vol. IV, p. 143, 1906.

———Notes and Descriptions of North American Parasitic *Hymenoptera*, Number V, pp. 101-102, 1907.

———Some Notes on the Geological History of Parasitic *Hymenoptera*. Journal New York Entomological Society, Vol. XVIII, No. 1, pp. 1-16, 1910.

———Drynidæ, in *Hymenoptera* of Connecticut. Connecticut State Geological and Natural History Survey. Bulletin 22, pp. 613-616, 1916.

BRADLEY, J. C.—Contributions to the Entomology of the Selkirk Mountains of British Columbia. Canadian Entomologist, Vol. 38, p. 380, 1906.

GIARD, A.—Sur une galle produite chez le *Typhlocyba rosæ*, par une larve *d'Hymenoptera*. Comptes Rendus, Ac. Sc. Paris, CIX, pp. 79-82, 1889.

———Sur la castration parasitaire des *Typhlocyba* par une larve *d'Hymenoptere* (*Aphelopus malaleucus* Dalm.), et par une larve de *Diptere* (*Ateleneura spuria* Meig.). Comptes Rendus, Ac. Sc. Paris, CIX, pp. 708-710, 1889.

HALIDAY, A. H.—Notes on the *Bethyli* and on *Dryinus pedestris*. Entomologists Magazine, Vol. 2, pp. 219-221, 1834.

HOOD, J. D.—Notes on the Life History of *Rhopalosoma poeyi* Cresson. Proceedings of the Entomological Society of Washington, Vol. XV, No. 4, pp. 145-148, 1913.

KEILIN, D., AND THOMPSON, W. R.—Sur les larves des *Dipteres* et *Hymenopteres* des *Typhlocybes*. Comptes Rendus des Seances de la Societe de Biology, T. LXXVIII, pp. 1-9, 1915.

KIEFFER, J. J.—Family *Dryinidæ*. Genera Insectorum, Fasc. LIV, 1907.

———Monograph of the *Bethylidæ*. Das Tierreich, 41 Lieferung, pp. 1-22, 1914.

KORNHAUSER, S. J.—Changes in *Thelia bimaculata* (Fabricius) Induced by Insect Parasites. Abstract Amer. Soc. of Zoologists, Columbus, Ohio, 1915.

———Further Studies on Changes in *Thelia bimaculata* brought about by Insect Parasites. Anatomical Record, Vol. 11, No. 6, pp. 538-540, 1916.

MARCHAL, P.—Les *Cecidomyies* des Cereales et leurs Parasites. Annales de la Societe Entomologique de France, pp. 1-105, 1897.

MIK, J.—Zur Biology von *Gonatopus pilosus* Thoms. Wiener Entomologische Zeitung, 1, pp. 215-221, 1882.

MISRA, C. S.—The Indian Sugar-cane Leaf-hopper *Pyrilla aberrans* Kirby. Memoires of the Department of Agriculture in India, Vol. V, No. 11, 1917.

PATTON, W. H.—Descriptions of Several New *Proctotrupidæ* and *Chrysidæ*. Canadian Entomologist, Vol. 11, p. 65, 1879.

PERKINS, R. C. L.—Leaf-hoppers and their Natural Enemies. (Part 1, *Dryinidæ*). Report of Work of the Exp. Sta. of the Hawaiian Sugar Planters Association, Bull. 1, part 1, 1905.

———ibid. Bull. 1, part 10, pp. 483-494, 1906.

ibid. Bull. 4, pp. 1-55, 1907.

———ibid. Bull. 11, pp. 5-17, 1912.

VAN DUZEE, E. P.—Catalogue of the *Hemiptera* of America North of Mexico. University of California, Technical Bull. Vol. 2, 1917.

SWEZEY, O. H.—Observations on Hymenopterous Parasites of Certain *Fulgoridæ*. Ohio Naturalist, III, pp. 444-451, 1903.

———Observations on the Life History of *Liburnia campestris* with Notes on a Hymenopterous Parasite infesting it. Bull. U. S. B. E. 46, pp. 42-46, 1904.

EXPLANATION OF PLATES.

Explanation of Plate I.

Fig. 1.   *Gonatopus erythrodes*, female.
Fig. 2.   *Phorbas mirabilis*, male.
Fig. 3.   *Aphelopus dikraneuri*, male.
Fig. 4.   *Phorbas mirabilis*, female.
Fig. 5.   *Gonatopus erythrodes*, male.
Fig. 6.   *Chelogynus osborni*, female.
Fig. 7.   Chela of *Gonatopus erythrodes*.
Fig. 8.   Chela of *Haplogonatopus americanus*.

Explanation of Plate II.

Fig. 1.   Normal male *Erythroneura comes*.
Fig. 2.   Parasitized *Erythroneura comes*.
Tes., testes; sto., storage stomach; hyp., hypertrophied tissue; par., parasite, fourth instar.

Explanation of Plate III.

Fig. 1.   Parasitized male *Erythroneura comes*, longitudinal section.
Fig. 2.   Normal male *Erythroneura comes*, longitudinal section.
par., parasite, fourth instar; hyp., hypertrophied tissue; tes., testes.

Explanation of Plate IV.

Fig. 1.   Normal male *Erythroneura comes*, cross section through second abdominal segment.
Fig. 2.   Parasitized female *Erythroneura comes*, showing nature of hypertrophied tissue in early phase, cross section through second abdominal segment.
Fig. 3.   Parasitized male *Erythroneura comes*, showing nature of hypertrophied tissue in late phase, cross section through point of attachment of parasite on first abdominal segment.
Fig. 4.   Parasitized male *Erythroneura comes*, cross section of same individual as Figure 3, through head of parasite on second abdominal segment.
Sto., storage stomach; tes., testes; hyp., layer of hypodermal cells developed around the wound produced in the host by the parasite; par., parasite; es., esophagus; hyp., hypertrophied tissue; ch., heavy layer of chitin at point of attachment of parasite.
Camera lucida drawings, ocular 7.5, objective 16 mm., Spencer Microscope.

Explanation of Plate V.

Fig. 1.   Normal male *Erythroneura comes*, cross section through second abdominal segment.
Fig. 2.   Parasitized male *Erythroneura comes*, cross section through metathorax, showing extreme anterior part of parasitic cyst.
Fig. 3.   Parasitized female *Erythroneura comes*, cross section through first abdominal segment just before attachment of parasite.
Fig. 4.   Parasitized male *Erythroneura comes*, cross section, third abdominal segment.
Sto., storage stomach; tes., testes; hyp., hypertrophied tissue; gen., rudiment of ovary; par., parasite.

Explanation of plate VI.

Fig. 1.   Parasitized male *Erythroneura comes*, cross section through second abdominal segment at point of attachment of parasite.
Fig. 2.   Parasitized male *Deltocephalus sayi*, longitudinal section through testis showing atrophy of this structure and disintegration of surrounding tissues. This individual was dying from the effects of parasitism at the time of fixation, the parasite being in the last stage.
Es., esophagus; hyp., hypertrophied tissue; m., membrane of cyst; par., parasite; tes., testis; int., intestine.

Fig. 1
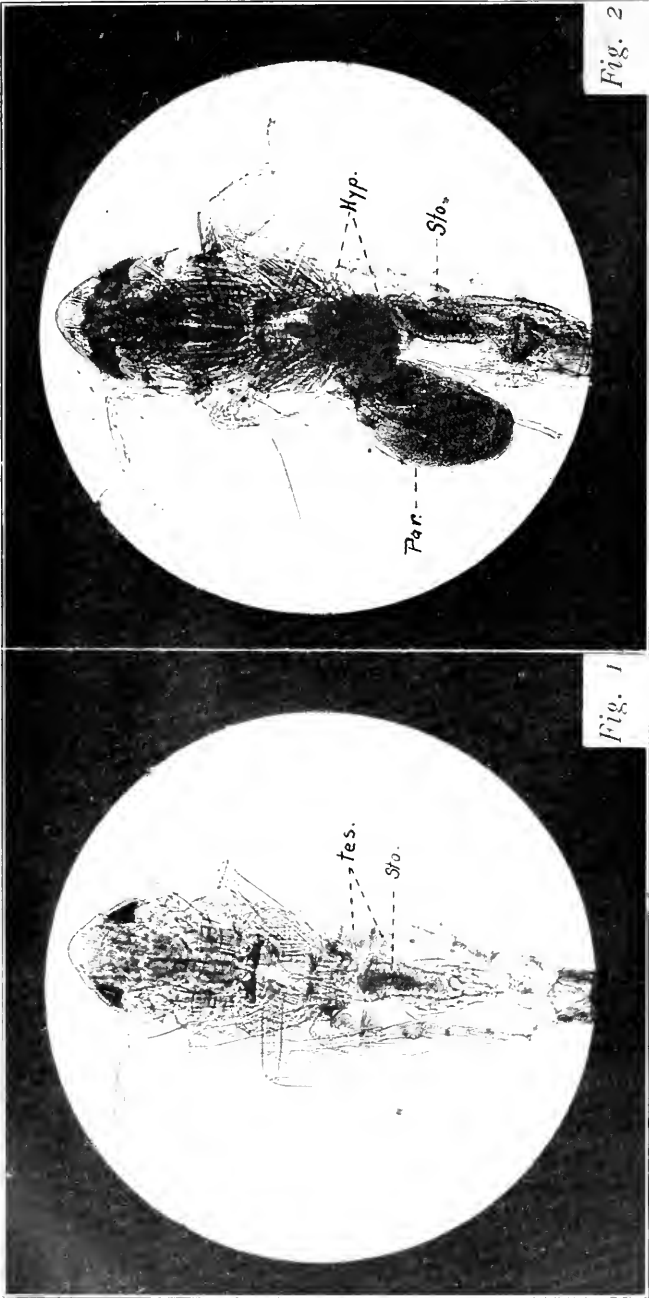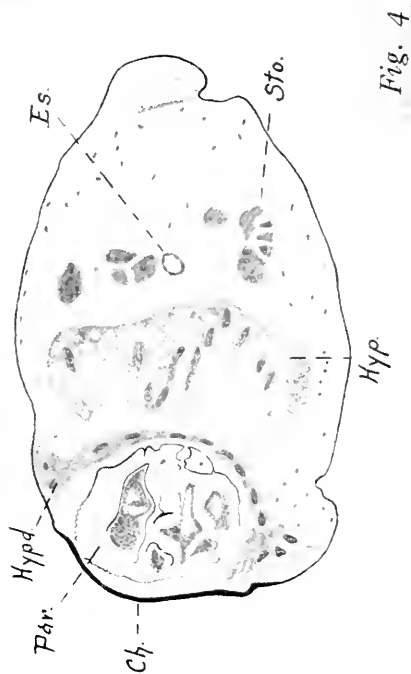

Fig. 2

A LIST OF OHIO SPIDERS.*
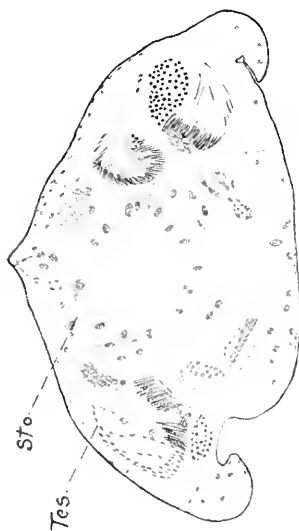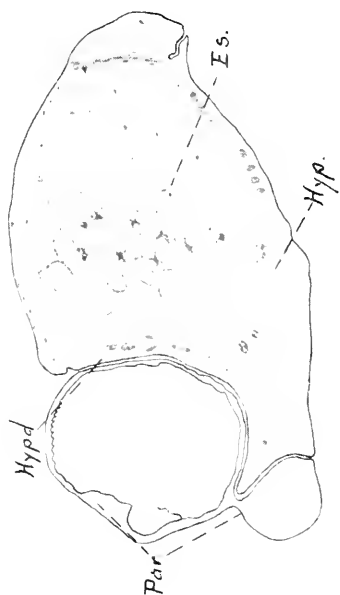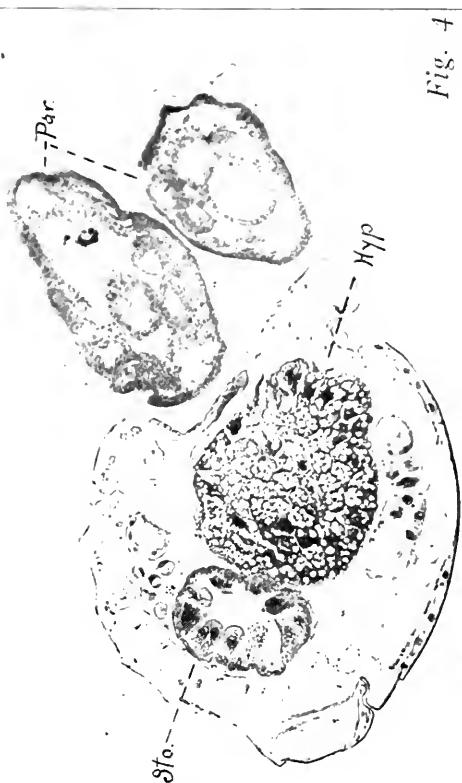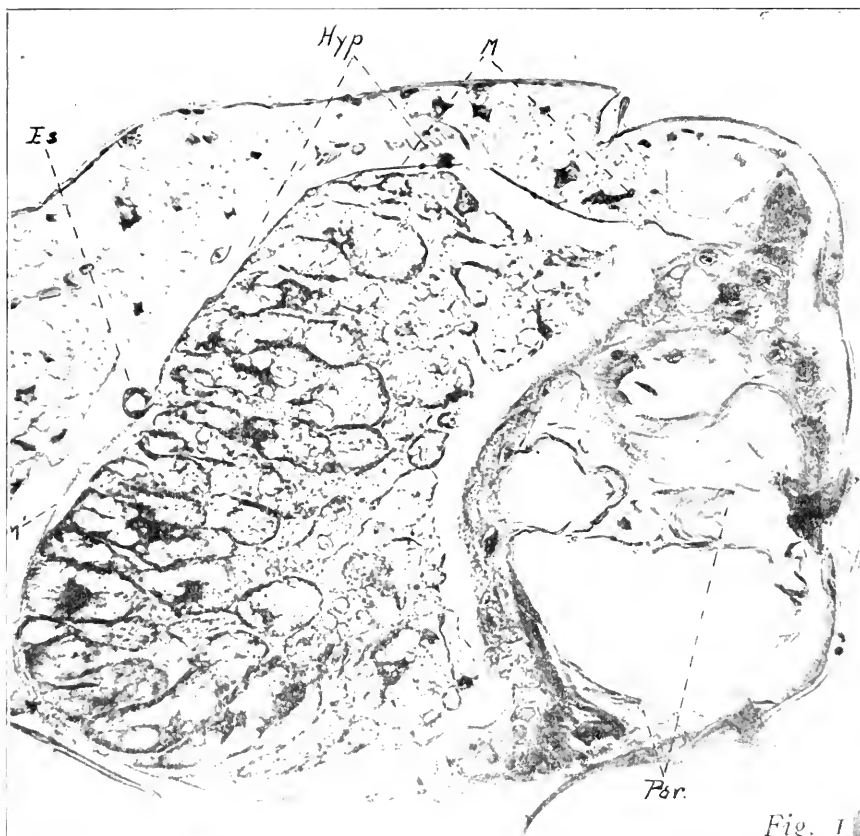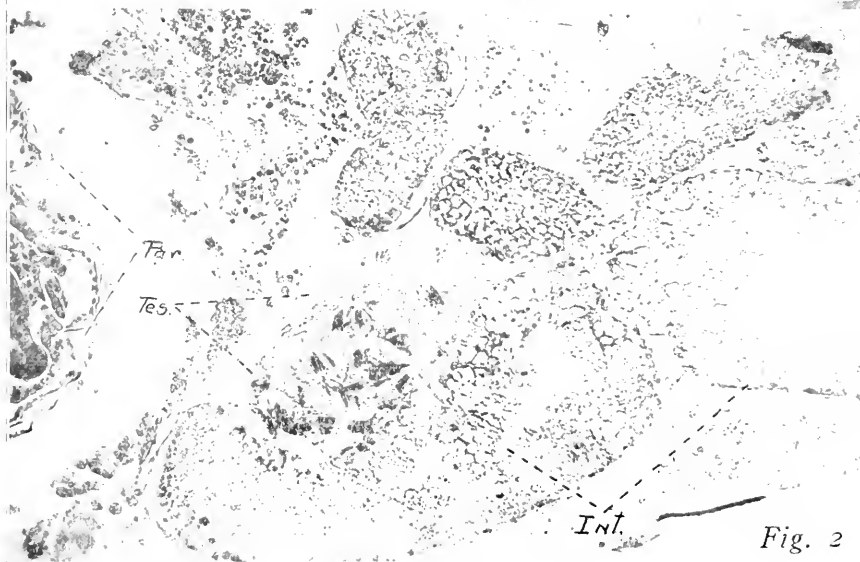
By W. M. Barrows.

The following list of 255 species of spiders is the result of five years of intermittent study of the spiders of the state. The work during the last two years has been carried on as a project of the Ohio Biological Survey.

I am much indebted to Mr. J. H. Emerton, of Boston, for his kindness in identifying the specimens collected in 1913, 1914, 1915, 1916, and part of 1917, and for much other help and advice. In the list, the specimens determined by Mr. Emerton are marked by an (E) placed after the name. A few specimens were determined by Mr. Nathan Banks. These are indicated by a (B). I am also indebted to the following persons for small collections made in various parts of the state: J. S. Houser, Wooster, Ohio; P. R. Lowry, Wooster, Ohio; R. J. Sim, Jefferson, Ohio; T. L. Guyton, Winterset, Guernsey Co., Ohio, and Chester I. Bliss, Sandusky, Erie Co., Ohio.

As far as possible the list follows the arrangement of the Catalogue of Nearctic Spiders by Nathan Banks, U. S. National Museum Bulletin 72, except that in each family the genera are here arranged alphabetically. Included in the list are the records of specimens collected in Ohio by Wm. Holden. These are recorded as notes by Emerton in a Collection of the Arachnological Writings of N. M. Hentz, Boston, 1875. These records are marked (W. H.). Two records of Attidæ are taken from the Peckham's Revision of the Attidæ of North America, and are indicated by a (P).

Several new species found in the collections will be described in a later paper.

THERAPHOSIDÆ.

Atypus milberti Walckenaer (B).
♀ Cedar Point, Ohio, August 15, 1913.
This specimen was taken from the stomach of a frog by Mr. C. J. Drake.

Atypus niger Hentz.
♂ Marietta, Ohio. (W. H.)

Brachybothrium pacificum Simon (B).
♂ ♀ Rockbridge, Ohio, September 7, 1915.
♀ Bainbridge, Ohio, August 17, 1917.
This very interesting "Folding-door Spider" builds its burrows along the bases of the moist overhanging cliffs. Its habits and life-history will be taken up in a separate paper. Up to the present time it appears to have been recorded only from the West Coast.

PHOLCIDÆ.

Pholcus phalangoides Fuessly.
♂ ♀ Columbus, Ohio.
A cellar or house species. Specimens were taken in the cellar of the Denton Brothers Packing Co. plant.

Spermophora meridionalis Hentz.
Marietta, Ohio. (W. H.)

DYSDERIDÆ.

Ariadne bicolor (Hentz).
♂ ♀ Cedar Point, Ohio, June 19, 1913. Ohio. (W. H.)
Common all over the state, building its tubular web in cracks of trees, buildings and rocks.

Dysdera interrita Hentz.
♂ ♀ Columbus, Ohio, June 13, 1913.
Common around Columbus, under boards and rocks.

DRASSIDÆ.

Callilepis imbecilla Keyserling. (E).
♂ Cedar Point, Ohio, June 19, 1913.
♀ Columbus, Ohio, June 11, 1914.

Cesonia bilineata (Hentz). (E).
♀ Cedar Point, Ohio, August 18, 1914.

Drassus hiemalis Emerton.
♂ ♀ Buckeye Lake, Ohio, June 24, 1917.

Gnaphosa bicolor (Hentz).
♂ ♀ Ohio. (W. H.)

Herpyllus ecclesiasticus Hentz. (E).
♀ Rockbridge, Ohio, April 11, 1914.
♂ ♀ Ohio. (W. H.)
Widely distributed. Lives under loose dry bark of dead or injured trees. Probably winters in the adult state.

Prosthesima atra (Hentz). (E).
> ♂ ♀ Rockbridge, Ohio, June 12, 1915.
> ♂ Columbus, Ohio, August, 1914.
> ♀ Marietta, Ohio.   (W. H.)

Prosthesima depressa (Emerton).
> ♂ ♀ Buckeye Lake, Ohio, June 24, 1917.

CLUBIONIDÆ.

Agroeca minuta Banks.
> ♀ Flint Ravine, eleven miles north of Columbus, July 4, 1917.

Anyphaena rubra? Emerton.   (E).
> Young, ♀ Rockbridge, Ohio, Fall, 1912.

Castianeira bivittata Keyserling. (E).
> ♀ Rockbridge, Ohio, June 1914.
> ♂ ♀ Ohio.   (W. H.)

Castianeira crocata (Hentz).   (E).
> ♂ ♀ Cedar Point, Ohio, July 4, 1914.
> ♀ Zanesville, Ohio.   (W. H.)

A female was found laying eggs at Columbus on November 10, 1917. Late in the summer this is one of the commonest black or black and red spiders on the ground in dry fields and pastures.

Castianeira pinnata (Emerton).
> ♂ Columbus, Ohio, September 2, 1915.

Castianeira trilineata (Hentz).
> ♀ Athens, Ohio.   (W. H.)

Chiracanthium viride Emerton.   (E).
> ♂ ♀ Columbus, Ohio, July, 1916.
> ♀ Cedar Point, Ohio, July 20, 1903.

Taken on shrubs and low vegetation in the woods which fringe streams and in moist woods. Hibernates nearly full grown under leaves and rubbish on the ground.

Clubiona crassipalpis Keyserling.   (E).
> ♀ Columbus, Ohio, June 11, 1917.
> ♂ ♀ Rockbridge, Ohio, June 18, 1916.

Clubiona minutissima Petrunkevitch.   (E).
> ♂ ♀ Columbus, Ohio, June 23, 1916.   Delaware, Ohio.   Rock-
> bridge, Ohio.

Clubiona mixta Emerton.   (E).
> ♀ Cedar Point, Ohio, July 5, 1914.
> ♂ Cedar Point, Ohio, August 31, 1914.

Clubiona ornata Emerton.
> ♀ Wooster, Ohio, August-September, 1917.

Taken while sweeping in grassland.

Clubiona pallens Hentz.   (E).
> ♂ Rockbridge, Ohio, June 18, 1916.
> ♀ Columbus, Ohio, July, 1916.

Clubiona rubra Emerton. (E).

♂ ♀ Columbus, Ohio, October 20, 1917.

These specimens are similar to the figures given by Emerton, Trans. Comm. Acad., Vol. VIII, 1890. Plate V, Fig. 6. They were found under logs and boards in a pasture.

Clubiona tibialis Emerton. (E).

♂ ♀ Cedar Point, Ohio.

Gayenna (Anyphaena) calcarata (Emerton). (E).

Erie Co., Ohio, 1915.

♂ ♀ Columbus, Ohio, July, 1916.

♂ ♀ Delaware, Ohio, June 24, 1916.

It is possible that two species are included under this name as two forms of males have been taken at the same time. These live in young trees in rather dense woods.

Gayenna (Anyphaena) incerta Keyserling. (E).

♀ Sugar Grove, Ohio, December 26, 1915.

Taken in sifting leaves under the snow.

Gayenna (Anyphaena) saltabunda (Hentz). (E).

♀ Rockbridge, Ohio, July 1, 1916.

Micaria longipes Emerton. (E).

♀ Columbus, Ohio, September 6, 1917.

♂ Sugar Grove, Ohio, September 11, 1917.

Found running in pastures and dry upland prairie. The young have been taken in sweeping tall grass.

Phrurolithus alarius (Hentz). (E).

♀ Columbus, Ohio, June 12, 1916.

♀ Zanesville, Ohio. (W. H.)

♂ Rockbridge, Ohio.

This and the following species are usually taken in moist leaves or rotting wood in deep woods.

Phrurolithus borealis Emerton. (E).

♂ ♀ Columbus, June 24, 1916.

Phrurolithus formica Banks. (E).

♀ and young. Columbus, Ohio, November 10, 1917, in ants nest.

♂ Rockbridge, Ohio, October 4, 1914.

These spiders were found living with the ant Crematogaster lineolata.

Trachelas ruber Keyserling. (B).

♂ Rockbridge, Ohio, June, 1914.

♀ Cedar Point, Ohio, August 19, 1914.

♀ Columbus, Ohio, October 22, 1917.

AGELENIDÆ.

Agelena naevia Walckenaer. (E).

This species occurs everywhere. The mature males and females are found from June to October, the height of the mating season being September. The females lay the eggs in sheltered places, preferably under bark and usually remain near the eggs until they die some time in the early winter.

Cicurina arcuata Keyserling.   (E).
  ♂ ♀ Sugar Grove, Ohio, December 26, 1915.
Cicurina brevis (Emerton).   (E).
   ♂ Columbus, Ohio, November 10, 1917.
   ♀ Rockbridge, Ohio, July 1, 1916.
  This species winters in the adult condition quite often with ants.
Mr. R. J. Sim collected several pairs for me at Jefferson, Ohio, on Nov.
21, 1917.   These were living peaceably with ants (Acanthamyops
latipes Walsh.).   Excepting that they are rather pale, they appear
perfectly normal.
Cicurina pallida Keyserling.   (E).
  ♂ ♀ Sugar Grove, Ohio, December 26, 1915.
Coelotes calcaratus Keyserling.(E).
  ♀ Rockbridge, Ohio, October 4, 1914.
Coelotes montanus Emerton.   (E).
  ♂ ♀ Rockbridge, Ohio, April 11, 1914.
Coras medicinalis (Hentz).   (E).
   Young, Cedar Point, Ohio, August 6, 1910.
  ♂ ♀ Columbus, Ohio, November 10, 1917.
  ♀ Sugar Grove, Ohio, December 26, 1915.
Hahnia agilis Keyserling.   (E).
  ♀ Columbus, Ohio, November 10, 1917.
  ♂ Sugar Grove, Ohio, December 26, 1915.
Hahnia cinerea Emerton.   (E).
  ♀ Columbus, Ohio, June 12, 1916.
   Sugar Grove, Ohio, July, 1915.
Tegenaria derhami (Scopoli).   (E).
  ♂ Columbus, Ohio, October 3, 1915.

DICTYNIDÆ.

Amaurobius sylvestris Emerton.   (E).
  ♀ Columbus, Ohio, November 10, 1917.
  This spider is found under logs, in crevices of bark and rocks all
all over the state.
Argenna obesa (?) Emerton.   (E).
   Trans. Conn. Acad. Vol. 16, p. 399.
  ♂ Rockbridge, Ohio, June 12, 1915.
  Mr. Emerton comments on this as follows: "You have one little
Argenna like our coast species, but twice as large as any I have seen.
Here it lives under straw along the shore and around the salt marshes
in exactly the same situations as Lophocarenum arenarium at Sandusky"
Dictyna frondea Emerton.   (E).
  ♀ Cedar Point, Ohio.
Dictyna longispina Emerton.   (E).
  ♂ ♀ Delaware, Ohio, June 30, 1917.
  ♀ Columbus, Ohio, May 24, 1916.
  Rather common in woods near the Olentangy River where it occurs
in hollow stems and under bark during May and June.

Dictyna minuta Emerton.
>   ♂ ♀ Columbus, Ohio, June 13, 1917.

Dictyna muraria Emerton.
>   ♂ ♀ Wooster, Ohio.
>   ♂ ♀ Buckeye Lake, Ohio, June 14, 1917.

Dictyna rubra Emerton.   (E).
>   ♂ Columbus, Ohio, June 24, 1916.

Dictyna volupis Keyserling.
>   ♂ ♀ Columbus, Ohio, June 11, 1917.

A very common and abundant species.   It winters nearly mature and becomes mature early in the spring.

Titanoeca americana Emerton.   (E).
>   ♀ Cedar Point, Ohio.

Titanoeca brunnea Emerton.
>   ♀ Delaware, Ohio, June 30, 1917.

THERIDIIDÆ.

Ancylorrhanis hirsuta (Emerton).   (E).
>   ♂ Rockbridge, Ohio, July 1, 1916.

Argyrodes cancellatum (Hentz).   (E).
>   ♂ ♀ Clifton, Ohio, July 14, 1917.
>   ♂ Rockbridge, Ohio, June 1914.

This pair was taken from the web of an Acrosoma spinea in rather deep woods. Other specimens have been taken at Cedar Point and Rockbridge.

Argyrodes trigonum (Hentz).   (E).
>   Rockbridge, Ohio, October 4, 1914.
>   ♀ Cedar Point, Ohio, August, 1913.
>   ♂ ♀ Sugar Grove, Ohio, July 15, 1915.

Very common in the webs of Frontinella communis in the Sugar Grove region.

Asagena americana Emerton.   (E).
>   ♀ Columbus, Ohio, June 13, 1917.
>   ♂ Columbus, Ohio, June 10, 1917.

Ceratinella brunnea Emerton.   (E).
>   ♀ Columbus, Ohio, June 9, 1916.

Ceratinella emertoni Cambridge.   (E).
>   ♂ ♀ Columbus, Ohio, May 24, 1916.

Ceratinella fissiceps (Cambridge).
>   ♀ Sugar Grove, Ohio, June 10, 1917.

Ceratinella minuta Emerton.
>   ♀ Flint Ravine six miles north of Columbus, Ohio.

Ceratinopsis alternatus Emerton.   (E).
>   ♂ ♀ Rockbridge, Ohio, June 27, 1917.

Ceratinopsis interpres Cambridge.   (E).
>   ♂ ♀ Rockbridge, Ohio, June 12 and 18, 1915.

Common on the Mountain Laurel and Huckleberry bushes in the dry upland woods of Hocking and Fairfield Counties.

Ceratinopsis nigripalpis Emerton.　(E).
♂ ♀ Rockbridge, Ohio, June 18, 1916.
　　Sugar Grove, Ohio, July 4, 1915.

Cornicularia pallida Emerton.
♂ Sugar Grove, Ohio, June 10, 1917.

Crustulina guttata (Emerton).　(E).
♀ Columbus, Ohio, October, 1917.
Found under the edges of logs and stones in low pastures.

Enoplognatha marmorata (Emerton).　(E).
♀ Cedar Point, Ohio, July 4, 1914.
♀ Columbus, Ohio.
Found in the usual places, under edges of logs, stones and boards in the edges of woods near the river.

Erigone autumnalis Emerton.　(E).
♂ Columbus, Ohio, October 16, 1917.

Erigone dentigera Cambridge.
♂ Delaware, Ohio, June 28, 1916.

Erigone longipalpis Emerton.　(E).
♂ ♀ Sugar Grove, Ohio, April, 1913.

Euryopis argentea Emerton.　(E).
♀ Sugar Grove, Ohio, July 15, 1915.

Euryopis funerea Emerton.　(E).
♂ Rockbridge, Ohio, July 1, 1916.
♀ Cedar Point, Ohio, August, 1913.
Very abundant in July on the lower branches of trees on the edges of a swamp one mile south of Delaware.

Latrodectus mactans (Fabricius).　(E).
♂ ♀ Rockbridge, Ohio, October 4, 1914.
♂ N. Kenova, Ohio, August 24, 1914.
♀ Ohio.　(W. H.).
♀ Marietta, Ohio.　(W. H.)
Very common on the ground in the upland prairies of Hocking County.

Lophocarenum arenarium Emerton.　(E).
Trans. Conn. Acad. Arts and Sci., Vol. 16, p. 391.
♀ Cedar Point.
This specimen was taken under rubbish at the waters edge on Sandusky Bay, Sandusky, Ohio. It has been found by Mr. Emerton on the salt marshes near Lynn, Mass., where it lives in quite similar situations.

Lophocarenum (Diplocephalus) erigonoides Emerton.　(E).
♂ ♀ Columbus, Ohio, October 20, 1917.
♂ ♀ Buckeye Lake, June 24, 1917.
Specimens have been taken on the ground, in the sweep-net, and from fences while they were balooning.

Lophocarenum (Hypselistes) florens (Cambridge).
♀ August-September, 1917, Wooster, Ohio.
Taken in sweeping in grassland.

Pedanostethus riparius Keyserling.

    ♂ ♀ Columbus, Ohio, September 22, 1917.

    ♂ ♀ Rockbridge, Ohio, June 12, 1915.

Very common in the moist woods which fringe the Olentangy river where it lives under rocks and boards.

Pedanostethus terrestris Emerton. (E).

    Jour. N. Y. Ent. Soc. XXII, p. 262.

    ♂ ♀ Bainbridge, Ohio, August 17, 1917.

Found under stones and leaves in a very deep moist ravine.

Spintharus flavidus Hentz.

    ♂ Brinkhaven, Ohio, September 15, 1917.

Spiropalpus (Cornicularia) spiralis Emerton. (E).

    ♂ Columbus, Ohio, June 23, 1916.

Steatoda borealis (Hentz). (E)

    Cedar Point, Columbus, Rockbridge, Brinkhaven, Ohio. (W. H.)

Besides living under bark and boards in most moist situations, this species makes a very large tangled web about a foot from the ground in the very thick growth of nettles and other plants in the low moist woods along the Olentangy River. They hibernate as adults.

Teutana triangulosa (Walckenaer).

    ♂ ♀ Columbus, Ohio, October 1915.

    ♂ ♀ Lancaster, Ohio. (W. H.)

Rather common in corners and behind cases in the Botany and Zoology Building, Ohio State University.

Theridium differens Emerton. (E).

    ♂ Rockbridge, Ohio, June 18, 1916.

    ♂ ♀ Delaware, Ohio, June 28, 1916.

    ♂ Cedar Point, Ohio, August 1, 1913.

Theridium frondeum Hentz. (E).

    ♀ Cedar Point, Ohio, July 4, 1914.

    ♂ ♀ Delaware, Ohio, June 28, 1916.

    ♀ New Lexington, Ohio, (W. H)

Widely distributed. Usually found in tall grass and shrubs near water.

Theridium kentuckyense Keyserling.(E).

    ♂ ♀ Rockbridge, Ohio, July 18, 1916.

Found on ferns and other vegetation in the extremely moist dark ravines of Hocking County.

Theridium murarium Emerton. (E).

    ♀ Columbus, Ohio, June 9, 1916.

    Cedar Point, Ohio.

Theridium rupicola Emerton. (E).

    ♂ ♀ Rockbridge, Ohio, June, 1914.

    ♀ Sugar Grove, Ohio, July 15, 1915.

Theridium spirale Emerton. (E).

    ♂ Columbus, Ohio, August, 1914.

Theridium tepidariorum Koch.   (E).

    ♂ ♀ Buckeye Lake, Ohio, June 24, 1917.

    ♂ ♀ Cedar Point, Ohio, August 6, 1910.

    ♂ ♀ Ohio.   (J. H. E.)

These spiders are commonly found in houses and other buildings. On the cliffs at Clifton Gorge, Bainbridge, Rockbridge and Brinkhaven, however, they appear to be living in the "wild" condition, not in any way associated with man.

Theridula sphaerula (Hentz).   (E).

    ♂ Bainbridge, Ohio, August 17, 1917.

Tmeticus (Gonglydium) flaveolens Emerton.   (E).

    ♂ Columbus, Ohio, November 10, 1917.

These were taken balooning.

Tmeticus longisetosus Emerton.

    ♂ Columbus, Ohio, March 12, 1918.

Taken near the river under a sheet of tin.

Tmeticus probatus (Cambridge).   (E).

    ♂ ♀ Rockbridge, Ohio, July 27, 1917.

Tmeticus terrestris Emerton.

    ♂ ♀ Columbus, Ohio, March 12, 1918.

Tmeticus tridentatus Emerton.

    ♂ Rockbridge, Ohio, September 30, 1917.

Tmeticus trilobatus Emerton.

    ♂ Columbus, Ohio, March 12, 1918.

Ulesanis americanus Emerton.   (E).

    ♂ Rockbridge, Ohio, June 18, 1916.

LINYPHIIDÆ.

Bathyphantes micaria Emerton.   (E).

Bathyphantes concolor (Reuss).   (E).

    ♂ Columbus, Ohio, Oct. 28, 1917.

Bathyphantes alboventris (Banks).   (E).

    ♂ ♀ Columbus, Ohio, June 11, 1917.

Hibernates in the adult state.

Bathyphantes nigrina (Emerton).   (E).

    ♂ Columbus, Ohio, October 20, 1917.

    ♀ Columbus, Ohio, June 11, 1917.

Very common in moist situations near or on the ground under rubbish or matted vegetation. Some of the males and many of the females survive the winter.

Drapetisca socialis Emerton.

    ♀ Rockbridge, Ohio, September 30, 1917.

Found running on the bark of beech trees growing with hemlocks in the moist ravines in Fairfield and Hocking Counties. I have taken specimens in the same kind of situations at Forest Hills, Mass.

Frontinella (**Linyphia**) **communis** (Hentz).   (E).
    ♂ Sugar Grove, Ohio, July 15, 1915.
    These spiders build tall rather striking dome webs, sometimes three feet high in the pine woods west of Sugar Grove in the same situations in which the Pink Lady's Slipper grows.

Lepthyphantes nebulosa (Sundervall).
    ♂ ♀ Columbus, Ohio, October 28, 1917.
    This pair was found copulating under a flat stone near the river.

Linyphia (**Diplosytla**) **brevipes** (Keyserling).
    ♂ ♀ Columbus, Ohio, March 12, 1918.
    Found under tin and boards near the river.

Linyphia (**Neriene**) **clathrata** Sundervall.   (E).
    ♂ ♀ Columbus, Ohio, June 13, 1917.
    ♂ Rockbridge, Ohio, June 12, 1915.
    ♀ Buckeye Lake, Ohio, June 24, 1917.
    In the woodlot north of the University this species builds its webs in the angles between the roots of the large trees.

Linyphia mandibulata Emerton.   (E).
    ♂ ♀ Jefferson, Ohio.
    ♂ Sugar Grove, Ohio, April, 1913.

Linyphia marginata Koch.   (E).
    ♂ ♀ Rockbridge, Ohio, June, 1914.
    ♂ ♀ Ohio.   (W. H.)
    Very common in the moist dense woods.

Linyphia phrygiana Koch.   (E).
    Young, Rockbridge, Ohio, May 27, 1916.
    ♀ Loudonville, Ohio, June 6, 1915.
    ♂ ♀ Ohio.   (W. H.)
    Found only on the undersides of branches in very moist woods, usually close to streams.   This species here does not live in the varied situations in which it is found in New England.   Matures early in May.

Microneta cornupalpis (Cambridge).
    ♂ Columbus, Ohio, November 10, 1917.

Nesticus pallidus Emerton.   (E).
    ♂ ♀ Columbus, Ohio, June 24, 1917.
    Found under sheets of tin and boards near the river.

Stemonyphantes bucculenta (Clerck).
    ♂ ♀ Columbus, Ohio, March 26, 1918.

Tapinopa bilineata Banks.
    ♂ Rockbridge, Ohio, September 30, 1917.
    ♂ Columbus, Ohio, August, 1917 (immature).

MIMETIDÆ.

Mimetus interfector Hentz.   (E).
    ♂ Columbus, Ohio, August, 1917.
    ♂ Sugar Grove, Ohio, July 15, 1915.
    Adults and young have been taken several times from the tops of weeds.

TETRAGNATHIDÆ.

Eugnatha pallidula Banks.

    ♂ ♀ Buckeye Lake, Ohio, July 21, 1917.

Eugnatha straminea (Emerton).   (E).

    ♂ ♀ Rockbridge, Ohio, June, 1916.

    ♂ Cedar Point, Ohio.

Eugnatha vermiformis (Emerton).   (E).

    Erie County, Ohio, 1915; young, Buckeye Lake, Ohio, Sept. 13, 1913.

Pachygantha tristriata Koch.   (E).

    ♂ ♀ Columbus, Ohio, October 20, 1917.

    ♂ Rockbridge, Ohio, Fall, 1912.

Found under logs in grassland and pastures. They hibernate as adults.

Tetragantha extensa (Linnaeus).   (E).

    ♂ Delaware, Ohio, June 18, 1916.

    ♂ ♀ Cedar Point, Ohio, August 6, 1910.

Tetragantha grallator Hentz.   (E).

    ♂ ♀ Columbus, Ohio, May 24, 1916.

    Rockbridge, Ohio, July 1, 1916.

    ♀ Buckeye Lake, Ohio, June 24, 1917.

    ♂ ♀ Cedar Point, Ohio.   Ohio.   (W. H.)

In central Ohio this species is usually found only near water, very often on grass which overhangs the water. Near the shore of Lake Erie, however, it lives in trees and on buildings often at a considerable height.

Tetragnatha laboriosa Hentz.   (E).

    ♂ ♀ Columbus, Ohio, June.

    ♂ ♀ Guernsey County, Ohio, June 16, 1916.

    ♂ ♀ Ohio.   (W. H.).

    ♂ ♀ Rockbridge, Ohio, May 27, 1916.

    ♀ Buckeye Lake, Ohio, June 24, 1917.

This is one of the commonest of the meadow and grassland forms. Its webs are built high up in the tops of the tall grasses. It matures early in June.

EPEIRIDÆ.

Acrosoma reduvianum McCook.

    ♀ Bainbridge, Ohio, August 17, 1917.

    ♀ Rockbridge, Ohio.

Apparently rather rare in Ohio. The webs are slung between trees or branches four to six feet above the ground in open woods.

Acrosoma gracilis (Walckenaer).   (E).

    ♂ Rockbridge, Ohio, June 22, 1914.

    ♀ Ohio.   (W. H.).

Females abundant in the late summer in dry beech, pine and oak woods. The webs are usually about breast high and connected to the supports by very long tough guy-lines.

Acrosoma spinea (Hentz).   (E).

⚥ Rockbridge, Ohio, July 1, 1916.
♂ ♀ Columbus, Ohio, July 7, 1914.
♀ Ohio.   (W. H.)

On low weeds in open places and in open woods where there is plenty of light.   Widely distributed, but never very abundant.

Argiope aurantia Lucas.   (E).

One of the most familiar and striking meadow spiders.   Universally distributed.   The web is placed low in thick grass or weeds.   The nearly mature female feeds very largely on grasshoppers.   The males mature in July when both sexes are small and inconspicuous.   After mating the female grows to a very large size.

Argiope trifasciata (Forskal).   (E).

♂ Winterset, Ohio, September 17, 1915.
♂ ♀ Columbus, Ohio, August-September.
Ohio.   (W. H.)

This is fully as common and widely spread as the preceeding, but is less conspicuous.   It lives in the same situations and matures somewhat later.

Cyclosa conica (Pallas).   (E).

♂ Loudonville, Ohio, June 6, 1915.
♂ Rockbridge, Ohio, May 27, 1916.

Taken in hemlock woods.   The webs are usually slung between tree trunks five or six feet above the ground.

Cyclosa turbinata McCook.   (E).

♂ Rockbridge, Ohio, July 1, 1916.
♀ Ohio.   (W. H.)

This species has been found only below cliffs where it builds its small orb web in weeds in the wettest situations.   It seems to prefer places where a fine mist falls on it or around it.

Epeira attestor (Petrunkevitch).   (E).

♀ Rockbridge, Ohio, July 18, 1916.

Epeira angulata Clerck.   (E).

This species is closely related to cavatica and is found in similar situations.

Epeira cavatica (Keyserling).   (E).

♂ Sugar Grove, Ohio, July 4, 1915.
Rockbridge, Ohio, October, 1913.

E. cavatica in Ohio seems to be limited to the faces of overhanging cliffs.   Mr. Emerton's comments on these specimens are interesting: "It was first described from Kentucky caves, but here in New England it is a northern species, living in great abundance on piazzas, in wagon sheds, and on barns all over Maine, New Hampshire and Vermont, coming south into northern Massachusetts, but not around Boston or further south.   Westward I have it from Spokane."

Epeira domicilorum Hentz.   (E).

♀ Columbus, Ohio, September, 1916.
Rather common on porches and barns in Columbus.

Epeira displicata Hentz.   (E).
    ♂ Rockbridge, Ohio, May 27, 1916.
    ♀ Loudonville, Ohio, June 6, 1915.
    ♂ Marietta, Ohio.   (W. H.)

Epeira ectypa Keyserling.   (E).
    ♀ Rockbridge, Ohio, October 4, 1914.

Epeira insularis Hentz.   (E).
    ♂ Bainbridge, Ohio, August 17, 1917.
      Cedar Point, Ohio.
      Ohio.   (W. H.)
  ♂ ♀ Columbus, Ohio, September 18, 1917.
    ♀ Rockbridge, Ohio, June 1914, and ♂ September 30, 1917.
A very common woodland form.   Found in low bushes in moist woods though usually in rather light situations.

Epeira juniperi Emerton.   (E).
  ♂ ♀ Rockbridge, Ohio, June 18, 1916.
Taken while beating branches of hemlock.

Epeira patagiata Clerck.   (E).
    ♂ Rockbridge, Ohio, June, 1914.
      Erie County, Ohio, 1915.

Epeira placida Hentz.   (E).

Epeira prompta Hentz.   (E).
      Rockbridge, Ohio, May 27, 1916.
    ♂ Buckeye Lake, Ohio, June 24, 1917.
    ♂ Columbus, Ohio, August, 1914.
    ♀ Cedar Point, Ohio.

Epeira sclopetaria (Clerck).   (E).   (B).
  ♂ ♀ Cedar Point, Ohio, June 28, 1913.
Very abundant on buildings near Lake Erie.

Epeira strix Hentz.   (E).
    ♂ N. Kenova, Ohio, August 24, 1915.
    ♂ Rockbridge, Ohio, July 27, 1917.
  ♂ ♀ Buckeye Lake, Ohio, June 24, 1917.

Epeira thaddeus Hentz.   (E).
    ♀ Rockbridge, Ohio, October 4, 1914.
    ♀ Columbus, Ohio, August, 1914.

Epeira trifolium Hentz.   (E).
  Widely distributed.
Very common over the state.   It seems to prefer tall weeds, particularly those which grow on the river flood plains.

Epeira trivittata Keyserling.   (E).
  ♂ ♀ Delaware, Ohio, June 6, 1916.
  ♂ ♀ Buckeye Lake, Ohio, June 24, 1917.
  ♂ ♀ Cedar Point, Ohio, July 21, 1910.
  ♂ ♀ Bainbridge, Ohio, August 17, 1917.
This spider is almost always present in tall grass, weeds, reeds and bushes.

Epeira verrucosa Hentz.　(E).

　　　♀ Bainbridge, Ohio, August 17, 1917.
　　　♀ Rockbridge, Ohio, August, 1915.
　　　♀ Columbus, Ohio, July, 1917.
　♂ ♀ Ohio.　(W. H.)

This striking species is rather common in the southern part of the state.　It builds its webs very high up between the trees in the thick moist woods.　The webs sometimes have guy-lines fifteen or twenty feet long.

Epeira vulgaris Hentz.

　　　♀ Brinkhaven, Ohio, September 15, 1917.

Glyptocranium cornigerum (Hentz).　(E).

　　　♀ Columbus, Ohio, November 1, 1915.

Leucauge hortorum (Hentz).　(E).

　♂ ♀ Rockbridge, Ohio, June 19, 1914.
　　　♀ Cedar Point, Ohio, June 27, 1913.

This striking green and silver spider is rather strictly limited to moist woodland.　It is widely distributed in the state.

Mangora gibberosa (Hentz).　(E).

　♂ ♀ Bainbridge, Ohio, August 17, 1917.
　♂ ♀ Columbus, Ohio, August, 1917.
　♂ ♀ Guernsey Co., 1916.
　　　　Erie Co., 1915.

Very common in the tops of grass and grain.

Meta menardi (Latrielle) (E).

　　　Immature ♂ ♀ Bainbridge, Ohio, August 17, 1917.

A cave species.　Found in dark wet situations along cliffs, or in the entrances of caves.

Metepeira labyrinthea Hentz.　(E).

　♂ ♀ Cedar Point, Ohio, July, 1915.
　　　♀ Rockbridge, Ohio, October 4, 1914.
　♂ ♀ Columbus, Ohio.

Commonly found in the branches of dead trees in the edges of woods all over the state.

Plectana stellata Walckenaer.　(E).

　　　♀ Cedar Point, Ohio, August 11, 1910.
　　　♀ Guernsey Co., Ohio, 1916.
　　　♀ Columbus, Ohio, September, 1916.
　　　♀ Rushville, Ohio.　(W. H.)

Singa keyserlingi McCook.　(E).

　　　♀ Cedar Point, Ohio, June 27, 1913, and August 13, 1910.

This species makes a small orb web in the tops of the dune grass (Andropogon).　During the day it stays in the hollow stems of the dead grass.　This form is probably not the same as S. pratensis.

Theridiosoma gemmosum (L. Koch).　(E).

　♂ ♀ Sugar Grove, Ohio, July, 1915.

This form may always be found in the wet moss on the faces of cliffs and in other wet situations in the deep woods.

ULOBORIDÆ.

Hyptiotes cavatus (Hentz.)   (E).
　　　♀ Rockbridge, Ohio, October 4, 1914.
　　　♂ ♀ Sugar Grove, Ohio, September 10, 1917.
　　Found in dark woods and ravines. Its triangle web is usually built in branches a few feet above the ground.

Uloborus plumipes Lucas (E).
　　　♂ ♀ Sugar Grove, Ohio, July 15, 1915.
　　　♂ ♀ Columbus, Ohio, June 24, 1916.

THOMISIDÆ.

Coriarachne versicolor Keyserling.   (E).
　　　♂ ♀ Columbus, Ohio, June 13, 1917.
　　　♀ Cedar Point, Ohio, July 24, 1913.
　　　♀ Buckeye Lake, Ohio, June 24, 1917.
　　Very abundant on or under the bark of trees.

Misumena celer (Hentz).
　　　♀ Marietta, Ohio.   (W. H.)

Misumena vatia (Clerck).   (E).
　　　♂ Rockbridge, Ohio, May 27, 1916.
　　　♀ Cedar Point, Ohio, August, 1913.

Misumessus asperatus (Hentz).   (E).
　　　♂ ♀ Columbus, Ohio, May 24, 1916.

Philodromus bidentatus Emerton.   (E).
　　　♂ Rockbridge, Ohio, June 18, 1916.
　　　♂ ♀ Cedar Point, Ohio.

Philodromus canadensis Emerton.
　　Canadian Entomologist, 1917, p. 270.
　　　♂ Cedar Point, Sandusky, Ohio, June, 1915.
　　Emerton states that this species is common about Montreal and Ottawa and westward to Lake Nipigon and Prince Albert.

Philodromus macrotarsus Emerton.   (E).
　　Canadian Entomologist, August, 1917, p. 271.
　　　♂ Columbus, Ohio, September 1, 1917.

Philodromus minutus Banks.
　　　♂ Buckeye Lake, Ohio, June 24, 1917.

Philodromus ornatus Banks.   (E).
　　　♀ Cedar Point, Ohio, August, 1913.

Philodromus pictus Emerton.   (E).
　　　♂ Loudonville, Ohio, June 6, 1915.

Philodromus vulgaris Hentz.   (E).
　　　♀ Buckeye Lake, Ohio, June 24, 1917.
　　　♀ Ohio.   (W. H.)

Runcinia aleatoria (Hentz).   (E).
　　　♂ Guernsey Co., Ohio, 1916.
　　　♀ Columbus, Ohio, August 23, 1917.

Synema parvula Hentz. (E).
>   Young, Cedar Point, Ohio.

This southern species occurs on the vegetation of the hot, dry sand dunes.

Thanatus coloradensis Keyserling.
>   Cleveland, Ohio, December 1915.

One specimen was collected by Emerton in the railroad restaurant. In a note in the Entomological News in 1917, he sums up situation in regard to this spider in the east as follows: "So it appears that we have here a western spider that takes readily to life about houses and is spreading across the country."

Thanatus lycosoides Emerton. (E).
>   ♂ Rockbridge, Ohio, October 4, 1914.
>   ♀ Columbus, Ohio, March 20, 1918.

Tibellus duttoni (Hentz). (E).
>   ♀ Cedar Point, Ohio, 1913.

Tibellus oblongus (Walckenaer).
>   ♀ Erie Co., Ohio, 1915.

Tmarus caudatus (Hentz). (E).
>   ♀ Rockbridge, Ohio, April 10, 1915.

Xysticus fraternus Banks. (B).
>   ♂ ♀ Columbus, Ohio, June 12, 1916.
>   Rockbridge, Ohio, June 11, 1916.

This species lives on the ground among the leaves in woodland.

Xysticus gulosus Keyserling. (E).
>   ♂ ♀ Columbus, Ohio, October 20, 1917.
>   ♀ Rockbridge, Ohio, June, 1914.

Very abundant in grassland.   In the fall this species with stomachosus makes up a large part of the balooning individuals.

Xysticus limbatus Keyserling. (E).
>   ♀ Cedar Point, Ohio, August, 1913.

Xysticus nervosus Banks. (E).
>   ♂ ♀ Columbus, Ohio, October 28, 1917.
>   ♂ ♀ Rockbridge, Ohio, October, 1913.

Xysticus quadrilineatus Emerton. (E).
>   ♀ Rockbridge, Ohio, October, 1913.

Xysticus stomachosus Emerton. (E).
>   ♀ Buckeye Lake, Ohio, June 24, 1917.
>   ♀ Columbus, Ohio, June, 1917.
>   ♂ ♀ Marietta, Ohio. (W. H.)

Xysticus triguttatus Keyserling.
>   ♂ ♀ Guernsey County, Ohio, June 16, 1916.
>   ♂ Rockbridge, Ohio, June, 1914.
>   Common in grassland.

PISAURIDÆ.

Dolomedes idoneus Montgomery = **vernalis** Emerton.   (E).
     ♂ ♀ Rockbridge, Ohio, June 12, 1915.
     ♀ Columbus, Ohio, June, 1917.
     ♂ ♀ Ohio.   (W. H.)

This large spider is rather common along river courses where it lives under loose bark and under logs.   Where cliffs occur near streams it becomes a distinct cliff species.   Mating occurs early in June.   The males which are smaller than the females, die and the females grow to be very large by midsummer.

Dolomedes sexpunctatus Hentz.   (E).
     ♂ ♀ Columbus, Ohio, June 25, 1916.
     ♂ ♀ Malta, Ohio, August 12, 1915.

Common around permanent ponds.

Dolomedes urinator Hentz.   (E).
     ♂ Columbus, Ohio, April 4, 1913.
     ♀ Rockbridge, Ohio, September 18, 1915.
     ♀ New Lexington, Ohio.   (W. H.)

These are probably the largest spiders which occur in Ohio.   Common in the ravines of Hocking County, on logs overrunning streams.

Pisaura brevipes Emerton.   (E).
     Trans. Conn. Acad. Arts and Sci., Vol. 16, p. 400.
     ♀ Sugar Grove, Ohio.
     ♀ Ashtabula Co., Ohio.

Pisaurina undata (Hentz).   (E).
     ♀ Delaware, Ohio, June 24, 1916.
     Young, Columbus, Ohio, June 10, 1914.
     ♀ Rockbridge, Ohio, July 27, 1917.
     Marietta, Ohio.   (W. H.)

The young during the summer are found on vegetation everywhere. One specimen from a cave was nearly white, but was otherwise normal.

LYCOSIDÆ.

Allocosa rugosa (Keyserling).   (E).
     ♂ ♀ Columbus, Ohio, June 12, 1917.
     ♂ ♀ Rockbridge, Ohio, June, 1917.

Running on the ground in warm, dry situations.

Lycosa avara Keyserling.   (E).
     ♂ ♀ Rockbridge, Ohio, October, 1913.

Lycosa baltimoriana (Keyserling).   (E).
     ♀ Cedar Point, Ohio, August, 1913.

Lycosa carolinensis Walckenaer.   (E).
     ♂ ♀ Columbus, Ohio, October 13, 1917.
     ♂ ♀ Ohio.   (W. H.)

Probably the commonest burrowing spider in Ohio.   It makes its burrows in lawns, pastures, and the edges of fields.

Lycosa (Trochosa) cinerea (Fabricius). (E).

    ♂ ♀ Cedar Point, Ohio, July 21, 1910.

    ♀ Marietta, Ohio. (W. H.)

This spider is at its optimum in the hot sands of the lake shore. Here it burrows into the loose sand, sometimes to a depth of six inches during the day. At night it emerges and hunts crickets and other insects.

Lycosa communis Emerton. (E).

    ♂ Buckeye Lake, Ohio, June 24, 1917.

    ♂ Columbus, Ohio, June 28, 1918.

    ♀ Marietta, Ohio. (W. H.)

Lycosa frondicola Emerton. (E).

    ♀ Rockbridge, Ohio, April 28, 1912.

    ♀ Cedar Point, Ohio, July 21, 1910.

Lycosa kochii Keyserling. (E).

    ♀ Delaware, Ohio, June 18, 1916.

    ♀ Columbus, Ohio, November 10, 1917.

Lycosa lenta Hentz. (E).

    ♀ Delaware, Ohio, June 30, 1917.

    ♂ ♀ Columbus, Ohio.

Lycosa (Geolycosa) missouriensis (Banks). (E).

    ♀ Cedar Point, Ohio, July 20, 1903.

One of the burrowing spiders which lives in sandy regions. Widely distributed in Eastern U. S.

Lycosa nidicola Emerton. (E).

    ♀ With eggs. Cedar Point, Ohio, July 12, 1903.

Widely distributed. Hibernates as adult. Common.

Lycosa pratensis (Emerton). (E).

    ♀ Cedar Point, Ohio, August, 1913.

Lycosa punctulata Hentz. (E).

    ♀ Rockbridge, Ohio, September, 1913.

    ♂ Rushville, Ohio. (W. H.)

Lycosa scutulata Hentz. (E).

    ♂ ♀ Rockbridge, Ohio, September 30, 1917.

    ♂ ♀ Ohio. (W. H.)

    ♂ N. Kenova, Ohio, August 24, 1915.

Very abundant in the dry upland prairies in the southern part of the state.

Lycosa tigrina McCook. (E).

    ♂ ♀ Rockbridge, Ohio, September 30, 1917.

Pardosa albopatella Emerton. (E).

    ♂ Rockbridge, Ohio, June 18, 1916.

    ♂ ♀ Columbus, Ohio, June 11, 1917.

Abundant in open ground early in June.

Pardosa glacialis (Thorell). (E).

    ♀ Buckeye Lake, Ohio, July 1, 1917.

A distinctly northern species. Found on the sphagnum bog in the center of Buckeye Lake.

Pardosa lapidicina Emerton. (E).
    ♂ ♀ Columbus, Ohio, June-July, 1916, Sandusky, Ohio.
Found on hot stones and clay banks near streams all over the state.

Pardosa nigropalpis Emerton. (E).
    ♂ ♀ Columbus, Ohio, June 11, 1917.
    ♂ ♀ Rockbridge, Ohio, June, 1914.
Very abundant in open ground in June.

Pardosa tachypoda Emerton.
    ♀ Erie County, Ohio, 1915.

Pirata minuta Emerton. (E).
    ♂ Brinkhaven, Ohio, June 5, 1915.
    ♀ Columbus, Ohio, September 8, 1917.

Pirata montana Emerton. (E).
    ♂ ♀ Brinkhaven, Ohio, June 6, 1916.

Pirata sylvestris Emerton. (E).
    ♂ ♀ Buckeye Lake, Ohio, July 21, 1917.

Schizogyna bilineata (Emerton).
    ♀ Buckeye Lake, Ohio, June 24, 1917.

Schizogyna ocreata (Hentz). (E).
    ♂ Marietta, Ohio. (W. H.)
    ♂ ♀ Columbus, Ohio, June 13, 1917.
    ♂ ♀ Rockbridge, Ohio, June, 1914.
Very abundant in fields and open woods.

Schizogyna relucens (Montgomery). (E).
    ♂ Columbus, Ohio, October 1, 1915.
    ♂ Sugar Grove, Ohio, July 4, 1915.

OXYOPIDÆ.

Oxyopes salticus Hentz. (E).
    ♂ ♀ Rockbridge, Ohio, July 27, 1916.
    ♀ Guernsey Co., Ohio, July 16, 1916.
This is a southern species and does not appear to occur north of Guernsey Co.   Found in the upland prairie vegetation.

ATTIDÆ.

Attidops youngi (Peckham).
    ♂ ♀ Brinkhaven, Ohio, September 15, 1917.
    ♀ Rockbridge, Ohio, September 10, 1917.
Several individuals were found crawling slowly on the face of cliffs about two miles north of Brinkhaven. One female was taken under hemlock bark at Rockbridge.

Dendryphantes capitatus (Hentz). (E).
    ♂ ♀ Columbus, Ohio, June 12, 1916.
    ♂ ♀ Buckeye Lake, Ohio, June 24, 1917.
    ♀ Cedar Point, Ohio.
    ♀ Rockbridge, Ohio.
Very common on grass and weeds in fields and at the edge of woods.

Dendryphantes castaneus (Hentz).   (E).
  ♀ Buckeye Lake, Ohio, June 24, 1917.
Dendryphantes militaris (Hentz).   (E).
  ♂ Rockbridge, Ohio, July 1, 1916.
  ♂ ♀ Guernsey Co., Ohio, June 16, 1916.
  ♂ ♀ Buckeye Lake, Ohio, September 13, 1913.
  ♂ Marietta, Ohio.   (W. H.)
Fuentes lineata (C. Koch).   (E).
  ♀ Buckeye Lake, Ohio, June 24, 1917.
  ♀ Rockbridge, Ohio, October 4, 1914.
Habrocestum parvulus (Banks).   (E).
  ♂ ♀ Rockbridge, Ohio, May 27, and June 18, 1916.
Habrocestum pulex (Hentz).   (E).
  ♂ ♀ Cedar Point, Ohio, August, 1913.
     Columbus, Ohio, June 9, 1916.
     Buckeye Lake, Ohio, June 24, 1917.
     Brinkhaven, Ohio, June 6, 1915.
Homalattus cyaneus (Hentz).   (E).
  ♂ Columbus, Ohio, July, 1916.
Hyctia pikei Peckham.   (E).
  ♂ ♀ Cedar Point, Ohio.
  Usually taken on cat-tails.
Icius hartii Emerton.   (E).
  ♀ Buckeye Lake, Ohio, June 24, 1917.
Maevia vittata (Hentz).   (E).
  ♂ ♀ Columbus, Ohio, May 23, 1916.
  ♂ Rockbridge, Ohio, June 22, 1914.
  Widely distributed.   Usually found on the ground or on low vegetation.
Marpissa binus (Hentz).
  ♂ ♀ Gypsum, Ohio, August 25, 1914.
Marpissa undata (DeGeer).   (E).
  ♂ ♀ Gypsum, Ohio, August 25, 1914.
  ♂ ♀ Ohio.   (W. H.)
  ♀ Buckeye Lake, Ohio, June 24, 1917.
  On fences and bark of trees.
Myrmarachne albocinctus (C. Koch).   (E).
  ♂ Rockbridge, Ohio, June 22, 1914.
  Much like an ant in appearance though not usually associated with ants.
Parnaenus (Phidippus) chryseus Peckham.   (E).
  ♂ ♀ Sugar Grove, Ohio, July 4, 1915.
  ♀ Columbus, Ohio.
  The specimen taken at Columbus was wintering in a curled leaf on a low branch.   A southern species.
Pellenes agilis (Banks).   (E).
  ♂ Cedar Point, Ohio, July 8, 1903.

Pellenes borealis (Banks). (E).
> ♂ ♀ Cedar Point, Ohio, 1913.
> ♂ Columbus, Ohio, May 24, 1916.

Pellenes coronatus (Hentz). (E).
> ♂ Brinkhaven, Ohio, June 6, 1915.

It is interesting to note that this southern species is found in the same region in which occurs the most northern stand in Ohio of the southern pines, Pinus rigida and Pinus virginiana.

Pellenes hoyi Peckham. (E).
> ♂ ♀ Delaware, Ohio, June 28, 1916.

Phidippus audax (Hentz). (E).

Common all over the state. Winters half grown and matures in May or June. The three spots on the abdomen of the young are orange; these become white in the adult.

Phidippus insignarius (C Koch). (E).
> ♂ ♀ Rockbridge, Ohio, June 12, 1915.

Phidippus mccooki (Peckham). (E).
> ♂ ♀ Guernsey Co., Ohio, September 2, 1916.

Phidippus multiformis Emerton. (E).

Very common over the state. It is found in grassland and in open woods. Matures in July and August.

Phidippus mystaceus (Hentz).
> ♂ ♀ Ohio. (W. H.)

Phidippus putnami (Peckham).
> ♂ Columbus, Ohio, August 20, 1917.
> Urbana, Ohio. (P.)

Phidippus whitmani Emerton. (E).
> ♂ Columbus, Ohio, June 1, 1914.
> ♂ Wooster, Ohio, June 6, 1915.

Phlegra leopardus (Hentz).
> ♂ ♀ Marietta, Ohio. (W. H.)

Salticus senicus (Clerck). (E).

Common on buildings and fences everywhere. Matures early in June.

Sittacus palustris (Peckham).
> ♂ Flint, Ohio, (North of Columbus), July 4, 1917.

Synemosyna picata Hentz. (E).
> ♂ Columbus, Ohio, June 24, 1916.

Synemosyna formica Hentz. (E).
> ♂ ♀ Brinkhaven, Ohio, June 6, 1915.
> ♂ Rockbridge, Ohio, July 1, 1916.

Synemosyna scorpiona Hentz. (E).
> ♀ Buckeye Lake, Ohio, June 24, 1917.
> Marietta, Ohio. (W. H.) Ohio. (P.)

Thiodina puerpera (Hentz).   (E).

    ♂ ♀ Rockbridge, Ohio, June 12, 1915, and June 18, 1916.

A distinctly southern form.   Taken in beating trees.

Tutelina elegans (Hentz).   (E).

    ♂ ♀ Delaware, Ohio, June 28, 1916.

    ♂ ♀ Cedar Point, Ohio, June 19, 1913.

Tutelina (Icius) formicaria (Emerton).   (E).

    ♂ Sugar Grove, Ohio, July 15, 1915.

    ♀ Rockbridge, Ohio, September 30, 1917.

A very striking spider.   One from the face of a cliff.

Wala mitrata (Hentz).   (E).

    ♂ Rockbridge, Ohio, July 18, 1916.

Wala palmarum (Hentz).   (E).

    ♂ ♀ Buckeye Lake, Ohio, September 13, 1913.

    ♂ ♀ Brinkhaven, Ohio, June 6, 1915.

Zygoballus bettini Peckham.   (E).

    ♂ ♀ Columbus, Ohio, May 24, 1916.

Zygoballus sexpunctatus (?) (Hentz).   (E).

    ♂ ♀ 1916.

DESCRIPTIONS OF SEVEN SPECIES OF ASILUS.
(Family Asilidæ).

Jas. S. Hine.

This genus was considered in Volume II, pages 136-172 of the Annals of the Entomological Society of America, and Banks added one additional species and gave a key to a section of the genus in Psyche, Volume XXI, page 131. Since publishing on these robberflies I have accumulated much material and from this the following additional species are described at this time.

Asilus gilvipes n. sp.

Large reddish species, legs all red with black bristles, posterior margin of the scutellum with four bristles, wings hyaline, oviduct conical, male forceps short. Total length 20 mm.

Face and front yellow pollinose, mystax composed mostly of yellow bristles, but with a few black ones above, beard straw yellow, antennæ palpi and proboscis black; thorax yellow pollinose, bristles of the dorsum black, wings hyaline, legs in all their parts red with black bristles; abdomen yellow pollinose, middle parts of the segments darker, giving a banded appearance, bristles mostly yellow; ovipositor short and distinctly conical, male forceps about as long as the seventh abdominal segment.

Holotype female from Saguache, Colorado, collected July 16, 1911, by A. K. Fisher, in the author's collection. An additional male and female with the same data, and an injured male from New Mexico belonging to the American Museum of Natural History.

Asilus comosus n. sp.

A rather large robust species with a hairy body, large mystax and brownish wings. Coxæ and basal half or more of the femora black, remainder of the legs red. Length of the female 18 mm.

Mystax very large, long and black, reaching nearly to the base of the antennæ, beard pale yellowish, postorbital bristles numerous and black. Thorax with numerous long black bristles dorsally, scutellum distinctly hairy above and with several long black bristles on the posterior margin. Wings plainly tinged with brown, nearly uniform colored all over, legs black to beyond the middle of the femora, otherwise red, with black bristles and pale hair. Abdomen dark, hind borders of the

segments dorsally pale, bristles and hair pale; transverse rows of numerous bristles before the incisures; female genitalia black, rather short, compressed.

Holotype female collected by W. M. Wheeler in Monterey County, California, July 5, 1896. Property of the American Museum of Natural History. Two other females with the same data.

This species is very distinct from all others known to me, and for that reason I allow myself to describe it from the female only. It seems to fall in the subgenus **Antipalus,** not heretofore reported from America.

Asilus vescus n. sp.

Small black species with the sides of the thorax and posterior margins of the abdominal segments gray pollinose. Male genitalia dark reddish brown. Total length 10 mm.

Mystax black above, white beneath; antennæ and proboscis black, beard white, thorax with two black stripes above very narrowly separated with a gray line, sides of the thorax gray pollinose, scutellum with some very fine gray hairs dorsally and two quite prominent black bristles on the posterior margin; wings hyaline, slightly gray on the posterior margin and at the apex; legs with femora wholly black, tibiæ and tarsi dark reddish. Abdomen black, venter and posterior margins of the segments dorsally gray pollinose. Male genitalia dark reddish brown, but not contrasting strongly in color with the abdominal segments, cut out at the apex above and produced backward and inward at the apex below, so that a small, but distinct, open space may be seen enclosed from dorsal view with a lens. Female genitalia shining black.

Holotype male from Monterey County, California, collected July 2, 1896, by W. M. Wheeler, property of the American Museum of Natural History. Several other males and females taken at the same time by the same collector.

Asilus delicatulus n. sp.

Body gray with pale bristles, wings hyaline, legs red, scutellum distinctly hairy with a row of white bristles on the posterior margin. Total length 11 mm.

This is a very distinct species and suggests at once its sand-inhabiting habits. It appears to be related to **A. leucopogon,** although the female ovipositor does not have a circuit of spines at the tip as in that species. The male has the last two abdominal segments and the genitalia bright yellowish red and the female has the ovipositor of the same color. The delicate

appearance, the uniform gray color of the body, white bristles everywhere and the row of numerous white bristles on the margin of the scutellum are amply sufficient to identify the species.

Holotype male from Las Cruces, New Mexico, collected by J. M. Aldrich June 16, 1917 and deposited in his collection. He procured two males and four females from the same place on the same date.

Asilus formosus n. sp.

Body yellowish gray pollinose all over, legs all red except each femur has a large darker spot on its anterior surface, wings clear hyaline, total length 18 mm.

Mystax pale yellowish, antennæ, palpi and proboscis black, beard white, postorbital bristles white, hair and bristles of the thoracic dorsum black, posterior margin of the scutellum with two black bristles, legs red with black bristles, each femur with a darkened patch on its anterior surface. Wings clear hyaline, bristles of the abdomen pale.

Holotype male from Clary County, Kansas, August 29, 1911, and another male from Stanton County, Kansas, July 29, 1911, both collected by F. X. Williams; in the author's collection. One male from Garden City, Kansas, August, 1895, H. W. Menke, collector.

Asilus citus n. sp.

Body dark, abdomen with alternate dark and gray bands, thorax thinly gray pollinose, middle of the dorsum with two black stripes very narrowly separated; femora, except base and apex, black; otherwise legs red with black bristles; genitalia red. Total length 12 mm.

Mystax white with a few black bristles above, beard white, postorbital bristles largely white, a few black ones near the vertex. Bristles of the thoracic dorsum black, scutellum with two black bristles on its posterior margin, wings hyaline, apex and posterior margin faintly gray.

Holotype male from Santa Rita Mountains, Arizona, taken in July; F. H. Snow; in the author's collection. Fifteen males and females from the same locality.

The banded abdomen and the dark red genitalia of both sexes, together with the small size suggest this species.

Asilus compositus n. sp.

Body slender, dark brown in color, legs yellowish brown, antennal bristles about twice as long as the third segment which bears it. This species is related to gracilis, which has the long antennal bristle also. Total length 17 mm.

Mystax white, very small, leaving a long distance between it and the base of the antennæ, beard white and sparse, posterior orbital bristles all pale; thorax lightly gray pollinose with black bristles dorsally, two black bristles on the posterior margin of the scutellum; legs yellowish brown, darker in places on the femora, bristles of the legs largely pale, but some black ones on the tibiæ and tarsi; wing hyaline, feintly gray on the hind margin and at the apex; abdomen dark with pale bristles. Genitalia dark brown, shining in both sexes.

Holotype male from San Diego, California, June 30, 1913, collected by E. P. Van Duzee; in the author's collection; a female with the same data, a male from Los Angeles County, California, collected by Coquillett, a male and female from Claremont, collected by Baker, and a male and female from Kerryville, Texas, collected by F. C. Pratt.

This species differs from **A. gracilis** in the much darker color of the whole body. The legs are brown instead of yellow and the mystax is white and not straw colored.

THE NORTH AMERICAN SPECIES OF TELEONEMIA OCCURRING NORTH OF MEXICO.

By Carl J. Drake.

New York State College of Forestry.

The genus *Teleonemia* of Costa belongs to that group in the family Tingidæ (Hemiptera-Heteroptera) which have the nervures or veins of the delicate lace-like structure much thickened and the peculiar lacy appearance which is so characteristic of the family is somewhat obscured. In the culmination of species the genus, no doubt, attains its maximum in the warmer climates, both tropical and subtropical America being represented by a number of closely allied forms; in fact it seems to be the genus which is most characteristic of the family Tingidæ of tropical America. The most northern localities represented by specimens before me are Utah, Kansas, Missouri and both North and South Carolina. Stål (1873, p. 131) enumerates eleven species, two from North America and nine from South America. Two species are listed by Uhler (1886, p. 22) for North America, *elongata* being a manuscript name. Champion (1898a, p. 34) gives fourteen species for Mexico and Central America, twelve being described as new. Both Banks (1910, p. 57) and Van Duzee (1917a, p. 26 and 1917b, p. 221) catalogue five species that have been taken north of Mexico. The present paper includes eight North American species that occur north of Mexico, *schwarzi*, *consors* and *barberi* being described herein as new.

Material Examined: The author is very much indebted to Professors Lovett, Ayers, Dean, Osborn, Ferris, Van Duzee, Johannsen and Knight for the loan or presentation of specimens of *Teleonemia*. Many thanks are also due to Mr. Edmund Gibson who has very kindly permitted the writer to study the determined species as well as the undetermined specimens in the National Museum.

According to Champion (1898a, p. 34) and Van Duzee (1917b, p. 221) the bibliography and synonymy of the genus *Teleonemia* may be stated as follows:

Genus **Teleonemia** Costa.

Type *funera* Costa.

Costa, Annuario del Museo Zoologico della R. Universita di Napoli, II, p. 144, 1864.

Stal, Enumeratio Hemipterorum, III, pp. 122 and 131, 1873.

Champion, Biologia Centrali-Americana, Rhynchota, II, p. 34, 1898.

Champion, Transactions of the Entomological Society of London for 1898, p. 61.

Distant, Fauna of British India, Rhynchota, II, p. 142, 1903 (names *funera* Costa type).

Van Duzee, Catalogue of the Hemiptera of America North of Mexico, p. 221, 1917.

 Americia Stal, Enumeratio Hemipterorum, III, p. 131, 1873 (subgenus of *Tingis;* type, *albilatera* Stal).

 Amaurosterphus Stal, Enumeratio Hemipterorum, III, p. 131, 1873 (subgenus of *Teleonemia;* haplotype, *morio* Stal).

 *Lasiacantha Lethierry et Severin, Catalogue Général des Hémiptèras, III, p. 18, 1894 (in part).

Narrow and elongate in shape. Head usually with five spines, the spines arranged as in related genera; bucculæ closed in front; antenniferous tubercles somewhat prolonged, obtuse. Antennæ rugulose, distinctly or indistinctly pilose, contiguous at the base; first and second segments short; third segment long, cylindrical or subcylindrical, obliquely truncate at the tip; fourth segment moderately long, more or less lanceolate or ovate. The length of the antennæ varies in different species and sometimes a little in the same species. Rostral groove uninterrupted, the rostrum varying in length in different species. Pronotum tricarinate; paranota narrow, uniseriate (except in *schwarzi*), folded back against or nearly against the pronotum proper; in *schwarzi* the paranota are almost wanting, barely more than carinate and with only two or three exceedingly narrow areolæ near the anterior margin. Metasternal orifices distinct. Hood indistinct or entirely wanting, but quite large in some Mexican and Central American species. Elytra extending considerably beyond the apex of the abdomen; discoidal and sutural areas co-elevated; costal and subcostal areas varying in width and number of rows of areolæ in different species. Wings present.

KEY TO THE AMERICAN SPECIES OF TELEONEMIA OCCURRING NORTH OF MEXICO.

1—Subcostal area almost entirely biseriate....... ....2.
 —Subcostal area uniseriate throughout.................. ....6.
2—Rostrum very long, extending beyond the apex of the rostral sulcus...........4.
 —Rostrum much shorter, extending to or very slightly beyond the meso-metasternal suture.... ....3.
3—Antennæ varying slightly in length, usually barely reaching the base of elytra, the third segment less than twice the length of the fourth; paranota with distinct areolæ...... ....*T. nigrina* Champion
 —Antennæ barely reaching the base of the elytra, the third segment slightly more than twice the length of the fourth; paranota almost wanting, scarcely more than carinate... ....*T. schwarzi* sp. new.
4—Insects 4 mm. or more in length; antennæ moderately stout, very slightly pilose; lateral carinæ diverging posteriorly...5.
 —Smaller insects, about 3.8 mm. long; antennæ rather slender, distinctly and quite densely pilose; lateral carinæ parallel..........*T. consors* sp. new.

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 * Name cited in error.

5—Costal area uniseriate throughout or uniseriate to beyond the middle and
  irregularly biseriate for a short distance towards the apex; general color
  testaceous or brownish testaceous, the elytra mottled with fuscous or
  blackish...*T. variegata* Champion.
 —Costal area uniseriate throughout; general color dark brown or fuscous-brown;
  third antennal segment becoming slightly smaller distally and about three
  times the length of the fourth........................*T. barberi* sp. new.
6—Discoidal area finely pubescent; costal area with rather large areolæ; antennæ
  reaching slightly beyond the base of the elytra, shortly pilose.
  ....*T. scrupulosa* Stal.
 ....Discoidal area glabrous; costal area with small or very small areolæ; antennæ
  reaching beyond the base of the elytra, indistinctly pilose...............7
7—General color testaceous or brownish testaceous, the elytra usually mottled
  with fuscous; costal area with small or very small areolæ; antennæ rather
  stout; anterior margin of pronotum slightly rounded, the median carina
  slightly elevated anteriorly......................*T. sacchari* Fabricius.
 —General color whitish testaceous, sometimes slightly mottled with brown;
  costal area with larger areolæ; anterior margin of the pronotum nearly tri-
  angular, the median carina distinctly elevated anteriorly; antennæ rather
  slender...*T. belfragei* Stal.

Teleonemia nigrina Champion.

Teleonemia nigrina Champion, Biologia Centrali-Americana, Rhynchota, Hemiptera-Heteroptera, Vol. II, p. 41, Tab. III, Figs. 13, 13a and 13b.   *Monanthia nigrina* Uhler MS. (Texas specimen in the British Museum).

Form moderately elongate, narrow; head with rather short, blunt and more or less prominent median spine.   Antennæ rather short, slightly variable in length, usually barely reaching the base of the elytra, the third segment less than twice the length of the fourth.   Rostrum extending to the meso- metasternal suture, the rostral groove abruptly and greatly widened on the metasternum.   General color above grayish or brownish gray, the elytra mottled with black, the body beneath black or piceous.   Pronotum rather finely punctate, subtruncate in front, rather sharply tricatinate, each carina with a row of small areolæ. Elytra moderately long, slightly constricted beyond the middle; costal area uniserate, the areolæ long, narrow and separated by strong transverse nervures; subcostal area biseriate.   In typical specimens the terminal ventral segment in the female is armed with a long, stout, obliquely projecting tubercle on each side.   Length 3–3.6 mm.; width 1–1.5 mm.

Mexico, Guatemala and Texas (Champion, 1898a, p. 41); New Mexico (Uhler, 1904, p. 362); Texas (Barber, 1906, p. 281); California (Van Duzee, 1914, p. 11).   I have before me over 250 specimens of *nigrina*, representing a great number of different localities in Texas, New Mexico, Arizona and California, also specimens from Kansas, Utah, Missouri, Arkansas, Georgia, North Carolina and South Carolina.

Van Duzee (1914, p. 11, and 1917c, p. 261) states that nigrina is "a common species everywhere in California" and has taken it in San Diego County feeding upon *Rhus laurina* and a leguminose plant allied to alfalfa. Specimens are at hand that bear the food plant labels as follows: Sugar beets (Spreckles, California, Sept. 20, 1904, collected by E. S. G. Titus); *Adenostegia (Cordylanthus) filafolia* (Campa, California, July 29, 1917, by W. D. Pierce); *Adenostegia pilosa* (Permanente Cr., Santa Clara County, California, August 12, 1917, by G. F. Ferris, who states "It occurs in great numbers on both the leaves and flowers of its host plants"); *Sphaeralcea augustifolia* (Rio Grande, Brewster County, Texas, by Mitchell and Cushman); *Verbena* (Marion County, Arkansas, July 15, by Mr. McElfresh, also Riley County, Kansas, September and October, by Mr. J. B. Norton); *Helenium tenuifolium* (Wolf Creek, Texas, August 5, 1906, by Dr. F. C. Bishop).

I have seen specimens of *nigrina* Champion labeled "*Teleonemia elongata* Uhler MS.," and this is probably the species listed by Uhler (1886, p. 22) and Smith (1909, p. 149) and Van Duzee (1917b, p. 222). The antennæ are slightly variable in length, but the third segment is always less than twice the length of the fourth. Van Duzee (1917c, p. 261) states, "Some of the females taken in company with the typical form have mere tubercles on the last ventral segment in place of the prominent horn-like processes figured by Champion." The tubercles of genital segment vary in size in the same specimen and sometimes they are entirely wanting.

Teleonemia schwarzi sp. new.

Moderately elongate, rather small; elytra testaceous, the nervures variegated with brownish fuscous. Head black, armed with short slender spines, the two frontal spines converging and the median spine very short or almost entirely wanting. Eyes black. Pronotum coarsely punctate, black or reddish black, the pubescence whitish, the surface of the disc shining; tricarinate, each carina very low and thin, the median carina with barely distinct areolæ, the lateral carinæ slightly diverging anteriorly and without distinct areolæ; paranota almost wanting, barely carinate. In some specimens the pubescence on the pronotum seems to be almost entirely rubbed off and disc is shining and appears much like the dorsal surface of the body in the genus *Alveotingis* O. & D. Rostral groove much widened on the metasternum, the rostrum extending to the meso- metasternal suture. Body beneath black or reddish black, the pubescence rather sparse and

whitish. Rostral laminæ yellowish brown. Legs reddish black or reddish brown, the distal portion of tibiæ somewhat testaceous; apex of tibiæ and tarsi blackish. Length, 2.64 mm.; width, .86 mm.

Antennæ barely reaching the base of the elytra, moderately strong, densely and rather longly pilose, dark brown; first and second segments very short, nearly equal in length; third segment a little more than twice the length of the fourth; fourth segment subequal to the length of the first and second conjoined. Elytra slightly narrowed beyond the middle, rounded at the apices; costal area narrow, uniseriate, the areolæ long narrow and separated by strong transverse nervures; subcostal area almost entirely biseriate. Wings a little longer than the abdomen.

Several specimens: San Diego (April, Coquillett) and Palm Springs (January 18 and March 9, Hubbard) California; Santa Rita Mountains, Arizona, collected by Dr. Schwarz. The species is named in honor of Dr. E. A. Schwarz of the National Museum, who has collected a great number of specimens of *Teleonemia* and other Tingidæ. *Type* in the National Museum, Washington, D. C. *Paratypes* in the National Museum, the California Academy of Science, Cornell University and the author's private collection.

Teleonemia consors sp. new.

Form similar to *variegata* Champion, but somewhat smaller. Antennæ rather slender, quite densely and distinctly pilose; first segment slightly longer than the second; third segment a little more than three times the length of the fourth. Pronotum nearly truncate in front, sparsely pubescent, distinctly tricarinate, the lateral carinæ parallel; paranota turned back against the pronotum proper. Rostral groove gradually widening posteriorly, the rostrum extending beyond the first ventral suture. General color fuscous or dark testaceous, the nervures partially darkened, the areolæ more or less grayish; body beneath brownish fuscous or blackish, the pubescence sparse and grayish. Legs dark fuscous or reddish fuscous with the tarsi darker. Rostral laminæ yellowish brown. Elytra long, somewhat oval in shape; costal area uniseriate, the areolæ rather large and mostly transparent; subcostal area biseriate; discoidal area large, widely reticulated. The elytra, except sutural area, are sparsely pubescent. Wings a little longer than the abdomen. Length, 3.5–3.6 mm.; width, 1.52 mm.

Six specimens; Bonita, Post Cr. Can., Arizona, July 16, 1917, by Mr. H. H. Knight; Oracle, Arizona, July. *Type* in author's collection. *Paratypes* in collection of H. H. Knight, Cornell University (Heidemann Collection) and author's collection.

Somewhat allied to *variegata* Champion and *pilicornis* Champion, but readily separated from the former by characters given in the key and from later by its shape, much longer rostrum, etc.

Teleonemia barberi sp. new.

Closely allied to *variegata* Champion, but readily separated from it by the much darker color, the uniseriate costal area, the much slender spines on the head and the shorter third antennal segment.

Elongate, rather broad, slightly smaller than *variegata* Champ., general color dark fuscous or dark brownish testaceous and slightly mottled with blackish.   Pronotum subtruncate in front, very coarsely punctate, distinctly tricarinæ, the outer carinæ divaricating posteriorly, the carinæ without distinct areolæ.   Rostrum extending to the posterior margin of the first ventral segment.   Antennæ stout, slightly pilose, rather long; third segment subcylindrical, almost three times the length of the fourth.   Elytra similar in shape to *variegata*, the subcostal area biseriate, the costal area rather broad and uniseriate.   Length, 3.9–4 mm.; width, 1.1–1.25 mm.

Numerous specimens, collected on "desert willow," *Chilopsis*, in the Huachuca Mts., Arizona, July 23, by Prof. H. G. Barber. I have also a single specimen from Valentine, Texas, July 8, 1917, that was collected by Dr. J. Bequaert.

Type in the collection of H. G. Barber.   *Paratypes* in the collections of Cornell University, H. G. Barber and the author.

Teleonemia variegata Champion.

Teleonemia variegata Champion, Biologia Centrali-Americana, Rhynchota, Hemiptera-Heteroptera, Vol. II, p. 42, Tab. III, Figs. 15 and 15a, 1898.

Elongate, rather broad, the largest species in the genus occurring north of Mexico.   General color testaceous or brownish testaceous, the elytra mottled with fuscous or black; body beneath reddish brown or fuscous.   Head with moderately slender or quite stout spines, the spines varying slightly in length in different specimens, the frontal spine either porrect or adpressed against the head.   Pronotum coarsely punctate, tricarinate, the carinæ without distinct areolæ, the median carina not raised anteriorly; paranota turned back against the pronotum proper.   Antennæ moderately stout, slightly pilose, long, the third segment from three to three and a half times the length of the fourth. Rostral groove gradually widening posteriorly, the rostrum extending to or a little beyond the second ventral suture.   Elytra long, somewhat

oval in shape; costal area prominent, entirely uniseriate or uniseriate to beyond the middle and irregularly biseriate for a short distance towards the apex, the areolæ large.   Legs sometimes marked or slightly annulated with fuscous, the tarsi black; apical segment of the antennæ partly or entirely fuscous.   Length, 4.1–4.5 mm.; width, 1.3–1.88 mm.

Barber (1910, p. 38) first records this species north of Mexico from specimens taken in the Huachuca Mts., Arizona. Champion (1898a, p. 42) describes the species from specimens taken in Mexico (Omilteme in Guerrero, 8,000 feet) and Guatemala (Capetillo, 4,000 feet).   I have examined specimens from Prescott and Huachuca Mts. (Barber, collector), Arizona and Cordoba, Mexico (Fred Knab, collector).

Teleonemia scrupulosa Stal.

Teleonemia scrupulosa Stal, Enumeratio Hemipterorum, Band, III, p. 132, 1873. *Teleonemia scrupulosa* Champion, Biologia Centrali-Americana, Rhynchota, Vol. II, p. 40, Tab. III, Figs. 12 and 12a, 1898.

Moderately elongate, rather narrow. General color dark gray or brownish, the elytra with darker markings, the pubescence whitish. Antennæ stout, moderately long, distinctly pilose, the third segment a little less than three times the length of the fourth.   Rostrum extending to the meso- metasternal suture, the rostral groove gradually widening behind the anterior coxæ. Pronotum with the carinæ moderately elevated and uniseriate, the paranota uniseriate, not quite turned back against the dorsal surface of the pronotum.   Elytra constricted back of the middle and widening towards the apices, with a transverse fascia before the apex; costal area moderately broad, the areolæ rather large and hyaline; discoidal area finely pubescent, the outer margin curved or sometimes nearly straight; subcostal area uniseriate.   Length, 3.25–3.9 mm.; width, 1.1–1.3 mm.

Champion (1898a, p. 41) reports this species as the most common *Teleonemia* occurring in Mexico and Central America. Numerous records have been published for the West Indian Islands and the tropical and subtropical regions of both North and South America by Stal (1873, p. 132), Champion (1898a, p. 40) and Van Duzee (1907, p. 22).   Barber records the species for Florida (1914, p. 507) and Texas (1906, p. 281). Seventy-six specimens are at hand, representing the following localities: Grenada, Jamaica, Guatemala, Mexico, Hayti, Florida and many records from Texas.

Scrupulosa has been taken on mint (Prof. Ayers) and poppy mallow, *Callirhoe involucrata*, (Mr. J. D. Mitchell) in Texas.

As stated by Champion (1898a, p. 41) the shortly pilose antennæ and pubescent discoidal area are the principal characters of the species.

Teleonemia sacchari Fabricius.

Acanthia sacchari Fabricius, Entomologia Systematica, Tom. IV, p. 77, 1794 ("Habitat in Americæ meridionalis Insulis"). *Tingis sacchari* Fabricius, Systema Rhyngotorum, p. 126, 1803. *Monanthia sacchari* Herrich-Schaffer, Die Wanzenartigen Insecten, p. 85, V, Tab. CLXXIII, Fig. 533, 1839. *Monanthia sacchari* Fieber, Entomologische Monographein, p. 76, Tab. VI, Figs. 22-25, 1844.

Antennæ slender, indistinctly pilose, brownish, the apical segment sometimes partially or entirely dark brown or fuscous; third segment a little less than three times the length of the fourth; fourth segment slightly longer than the first and second taken together. Head reddish brown, the median spine semi-erect and the dorsal spines a little longer than in *belfragei*. General color brown, the elytra more or less variegated with fuscous, the body beneath reddish brown. Pronotum sparsely pubescent, brown or reddish brown, the carinæ uniseriate, a little thicker and not so highly elevated as in *belfragei*. Median carina much less elevated anteriorly and the anterior margin of pronotum more rounded than in *belfragei*. Legs pale brown, the tips of tibiæ and tarsi black. Elytra with the costal area narrow, the areolæ long and very narrow; subcostal area biseriate; discoidal area glabrous. Length, 3.7-3.85 mm.; width, 1-1.2 mm.

Brazil and Mexico (Fieber, 1844, p. 76, and Herrich-Schaffer, 1839, p. 85); Cuba and Island of St. Bartholomew (Stal, 1873, p. 132); Lower California? (Uhler, 1894a, p. 278); Jamaica (Van Duzee, 1907, p. 22); Balthazar, Is. St. Vincent (Uhler, 1894b, p. 202-203, *in part*); Biscayne Bay and Key West, Florida (Barber, 1914, p. 507). Of this species I have examined twenty-nine specimens, representing the following localities: Island of St. Vincent, Grenada, Cuba, Jamaica (Mandeville, Van Duzee coll.) and Florida (Key West, Jan. 30, 1869, L. Worth, Feb. 6, 1887, and Biscayne, Sept. 20, 1889).

The general color, length of the antennæ and width of the costal area is somewhat variable in this species. In a series of specimens from Grenada the third segment of the antennæ varied .28 mm. in length. In most specimens the areolæ in the costal area are very narrow.

Teleonemia belfragei Stal.

Teleonemia belfragei Stal, Enumeratio Hemipterorum, Band. III, p. 132, 1873.   Champion, Transactions of the Entomological Society of London for 1898, p. 62, Pl. III, Fig. 8.

General color whitish testaceous; head, pronotum anteriorly and body beneath slightly tinged with ferruginous; elytra usually with a few brown or fuscous spots on the nervures.   Antennæ slender, indistinctly pilose, whitish testaceous, the apical segment brown or fuscous; first and second segments subequal; third segment nearly three times the length of the fourth; fourth segment subequal to the length of the first and second taken together.   Pronotum sparsely pubescent, tricarinate, each carina uniseriate and strongly elevated; median carina elevated anteriorly, the anterior margin of the pronotum nearly triangular and projecting slightly over the base of the head.   Head sparsely pubescent, the median spine suberect.   Legs mostly pale testaceous, the tarsi black.   Elytra with the costal area moderately broad, uniseriate, the areolæ hyaline, a little longer than broad, the transverse nervures strong, brown and usually four or five of them black.   Rostrum extending slightly beyond the meso-metasternal suture.   Length, 3.4–3.55 mm.; width, 1.1–1.25 mm.

Texas (type locality, Stal, 1873, p. 132).   Florida: Crescent City, Sanford and Biscayne (Van Duzee, 1909, pp. 173-174); Crescent City, Biscayne Bay and Lakewood (Barber, 1914, p. 507).   I have examined seven specimens from Jacksonville (Ashmead) and Crescent City, (Heidemann and Van Duzee) Florida.

The slender antennæ, the elevated median carina anteriorly, lighter color, etc., readily separate this species from *T. sacchari* Fabr.   Numerous specimens taken at Gainesville, Fla., May 1918, have the elytra slightly mottled with brown.   This is a very common species in Southeastern United States and feeds on the French mulberry, *Callicarpa Americana* in Florida.

LITERATURE CITED.

Banks, Nathan.
    1910. Catalogue of the Nearctic Hemiptera-Heteroptera.
Barber, Harry G.
    1906. Hemiptera from Southwestern Texas. Museum of the Brooklyn Institute of Arts and Sciences. Science Bulletin, Vol. I, No. 9, pp. 255-289.
    1910. Some Hemiptera Heteroptera New to the Fauna of United States. Journal of the New York Entomological Society, Vol. XVIII, pp. 34-39.
    1914. Insects of Florida. II. Hemiptera. Bulletin of the American Museum of Natural History, Vol. XXXIII, Art. XXXI, pp. 495-535.
Champion, George C.
    1898a. Biologia Centrali-Americana, Rhynchota, Hemiptera-Heteroptera, Vol. II, pp. 1-48.
    1898b. Notes on American and other Tingidæ, with descriptions of two New Genera and four new Species. Transactions of the Entomological Society of London, pp. 55-64, pls. II and III.
Distant, William L.
    1903. Fauna of British India. Rhynchota, Vol. II.
Fabricius, Johann C.
    1794. Entomologia Systematica, Tom. IV.
    1803. Systema Rhyngotorum.
Fieber, Franz Xavier.
    1844. Entomologische Monographein.
Herrich-Schaffer, Gottlieb, A. W.
    1839. Die Wanzenartigen Insecten, V.
Lethierry, L. et Severin, G.
    1894. Catalogue General des Hemipteres, Tom. III, Heteropteres.
Smith, John B.
    1910. Catalogue of the Insects found in New Jersey, 3rd Edition.
Stal, Carl.
    1868. Hemiptera Fabriciana.
    1873. Enumeratio Hemipterorum, Band. III.
Uhler, Philip Reese.
    1886. Check List of the Hemiptera-Heteroptera of North America.
    1894a. Hemiptera of Lower California. Proceedings of the California Academy of Science, Vol. IV, pp. 223-295.
    1894b. On the Hemiptera-Heteroptera of the Island of Grenada, West Indies. Proceedings of the Entomological Society of London, pp. 167-224.
    1904. List of the Hemiptera-Heteroptera of Las Vegas, Hot Springs, New Mexico, Collected by Messrs E. A. Schwarz and Herbert Barber. Proceedings of the United States National Museum, Vol. XXVII, pp. 349-364.
Van Duzee, Edward P.
    1907. Notes on Jamaican Hemiptera. Bulletin of the Buffalo Society of Natural History, Vol. VIII, pp. 3-79.
    1909. Observations on some Hemiptera taken in Florida in the spring of 1908. Bulletin of the Buffalo Society of Natural History, Vol. IX, pp. 149-230.
    1914. A Preliminary List of the Hemiptera of San Diego County, California. Transactions of the San Diego Society of Natural History, Vol. II, pp. 1-57.
    1917a. Check List of the Hemiptera North of Mexico.
    1917b. Catalogue of the Hemiptera of America North of Mexico.
    1917c. Report upon a collection of Hemiptera made by Walter M. Giffard in 1916 and 1917, Chiefly in California. Proceedings of the California Academy of Science, Vol. VII, pp. 249-318.
Walker, Francis.
    1873. Catalogue of the Specimens of Heteropterous-Hemiptera in the collection of the British Museum, Vol. VI.

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